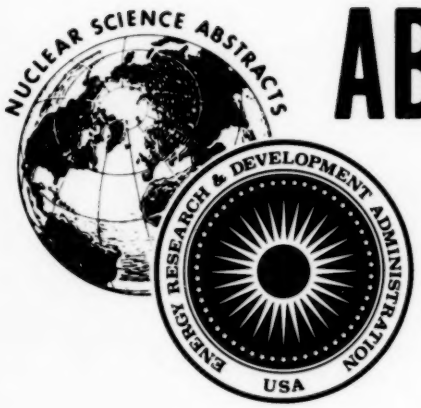
NUCLEAR SCIENCE ABSTRACTS



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July 31, 1975

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Volume 32, Number 2, July 31, 1975

NUCLEAR SCIENCE ABSTRACTS

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Published by the ERDA Technical Information Center

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HOLLOWAY, J.A., Survey of image processing methods for radiography, 31:16451
HOLLWEG, J.V., Hydromagnetic waves in interplanetary space, 31:17953
HOLMBERG, E.B., Distribution of clusters of galaxies as related to galactic absorption, 31:16040
HOLMES, J.J., See BATES, J.F., 31:17444

Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

NUCLEAR POWER PLANTS/REACTOR LICENSING
Experience acquired in the design and construction of operating plants (German Federal Republic), 31:19104
NUCLEAR POWER PLANTS/REACTOR SAFETY
Conception of radiation safety in atomic electric power plants, 31:15032 (CONF-701074-P1)
NUCLEAR POWER PLANTS/SITE SELECTION
Safety-related site parameters for nuclear power plants, 31:19052 (WASH-1361)
Status and development of nuclear power in the Federal Republic of Germany, 31:19105
NUCLEAR PROPERTIES/RESEARCH PROGRAMS
Accelerator physics group progress report, July--December 1973 (Research summaries), 31:18544 (INS-R-139)

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17606 (ANL/HEP-7440, pp I.1-I.12) ACCELERATED POLARIZED PROTONS AT THE ZGS. Ratner, L. G. (Argonne National Lab., IL). Feb 1974.
From symposium on high energy physics with polarized beams; Argonne, Illinois, USA (8 Feb 1974).
In symposium on high-energy physics with polarized beams.

is indexed as:

ARGONNE NATIONAL LAB., ILL. (USA)
Accelerated polarized protons at the ZGS, 31:17606 (ANL/HEP-7440)
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Analysis of population, birth, and death statistics in the counties surrounding the Big Rock Point Nuclear Power Station, Charlevoix County, Michigan, 31:16552 (ANL-8149)
Argonne polarized target facilities, 31:17762 (ANL/HEP-7440)
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Public availability of all U. S. Energy Research and Development Administration reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

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Volume 32, Number 2 July 31, 1975

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical and Separations Chemistry

Refer also to abstract 3968.

Activation and Nuclear Reaction Procedures

Refer also to abstract 3606.

2951 (AWRE-O-7/75) GAMMA SPECTROMETRY AND DATA PROCESSING FACILITIES FOR NEUTRON ACTIVATION ANALYSIS. Bundy, J. K.; Wood, G. A.; Goode, G. C. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Mar 1975. 21p. Dep. NTIS (US Sales Only) $4.25. UK 50 pence.

The gamma spectrometry and data handling system at the Atomic Weapons Research Establishment is described in detail. Computational methods and examples of on-line output are given. (LK)

2952 (CEA-CONF-2950) BIOLOGICAL SAMPLE CONTAMINATION DUE TO QUARTZ CONTAINER IN NEUTRON ACTIVATION ANALYSIS. Maziere, B.; Gaudry, A.; Gros, J.; Comar, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Biologie; CEA, 91-Orsay (France). Service Hospitalier Frederic Joliot). 1974. 23p. (CONF-741023-7). Dep. NTIS (US Sales Only) $4.25.

From 7th materials research symposium; Gaithersburg, Maryland, USA (7 Oct 1974).

Surface etching of the fused quartz irradiation container to a depth of 20 μm affects neither the mechanical properties of the ampoule nor its macroscopic aspect, the glass remaining polished and transparent. However it considerably lowers the "wet-ashing blank" level for many elements. As a result it is now possible to analyze fairly accurately (influence of the blank < 10%) the elements Cu, Hg, Fe, Cr, Cs, Zn, and Co in 100 μl of blood serum by neutron activation in a natural silica glass ampoule. These elements supplement the list of 8 elements (Se, K, Ba, Br, Na, P, Rb, Sr) that can be measured accurately by irradiation in an untreated fused quartz ampoule. However the "wet-ashing blank" still interferes strongly with the determination of seric gold (150%). For this analysis it is recommended to use a fused silica container, which, etched to a depth of 20 μm, would only release about a hundredth the quantity of gold contained in the serum sample during the "wet-ashing" process. (auth)

2953 (CONF-731229-P16A, pp 67-76) ANALYTICAL TECHNIQUES IN BASIC RESEARCH. Venkatasubramanian, V. S. (Indian Inst. of Science, Bangalore). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27-31, 1973. Volume 16A.

Analytical techniques for trace characterization are reviewed. These include atomic absorption, XRF, neutron activation and spark source and isotope dilution mass spectrographic techniques. Examples of the relation of trace impurities to physical properties and applications to basic research are summarized. Techniques relating to the valence state and chemical environment of the impurity species are treated next: magnetic resonance, Mossbauer and electron spectrometry in its various forms. The location (lattice, grain boundary etc.) as well as concentration of minor phases by electron and ion microprobe methods, as well as the lattice location of ion-implanted dopants by channelling techniques is next considered. Finally, the characterization of imperfections by optical and electron microscopy and field-ion microscopy are briefly reviewed with relevance to problems of basic research. (auth)

2954 (N-74-19768) NEUTRON ACTIVATION ANALYSIS FOR ANTIMETABOLITES. Final Report. (Institute for Research, Houston, Tex. (USA)). 29 Nov 1973. Contract NAS9-11940. 38p. (NASA-CR-134221). NTIS.

Determination of metal ion contaminants in food samples is studied. A weighed quantity of each sample was digested in a concentrated mixture of nitric, hydrochloric and perchloric acids to affect complete solution of the food products. The samples were diluted with water and the pH adjusted according to the specific analysis performed. The samples were analyzed by neutron activation analysis, polarography, and atomic absorption spectrophotometry. The solid food samples were also analyzed by neutron activation analysis for increased sensitivity and lower levels of detectability. The results are presented in tabular form. (auth)

2955 NEUTRON-ACTIVATION DETERMINATION OF MAGNESIUM IN TRIPLE FERRITES, $MnFe_2O_3-MgFe_2O_4-ZnFe_2O_4$. Girei, E. I.; Lobanov, E. M. (Inst. of Solid State Physics and Semiconductors, Minsk). Dokl. Akad. Nauk BSSR; 19: No. 1, 27-30(Jan 1975). (In Russian).

Problems related to determination of magnesium in ferrites of the ternary system $MnFe_2O_4-MgFe_2O_4-ZnFe_2O_4$ were considered, and the impossibility of determining magnesium by the radioisotope ^{27}Mg was shown. The amount of magnesium and sodium available in the samples was such that analysis for magnesium could be carried out by the $^{24}Mg(n,p)^{24}Na$ reaction using a cadmium filter. (tr-auth)

2956 USE OF REAL TIME PROCEDURES IN THE SEMI-AUTOMATIC ANALYSIS OF ASCARIS LUMBRICOIDES VAR. SUIS. Ince, A. J. (London Univ.). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 220-222(Apr 1975).

A method used for the counting of samples in real time, whilst accumulating live time, achieved by the modification of analyzers to accumulate real and live time simultaneously and time counts on either is described. The system was designed for routine analysis of large numbers of samples, which could operate unattended, and its use in the determination of the elements cobalt, zinc, manganese, copper, sodium, potassium, and bromine in Ascaris lumbricoides var. suis, a parasitic round worm, is described. (UK)

2957 SIMPLE METHOD FOR THE DETERMINATION OF MERCURY IN ROCKS BY ACTIVATION ANALYSIS. Rosenberg, J.; Salmela, S. (Tech. Research Centre, Helsinki). Radiochem. Radioanal. Lett.; 21: No. 1-2, 23-30(14 Apr 1975).

A description is given of a method for the determination of mercury in rocks; its main feature is the rapid separation of mercury. The irradiated sample is heated in an induction furnace, and the mercury vapors expelled are adsorbed on filter paper impregnated with selenium. The yield of separation is 90%, and the total time taken by the procedure is about 6 minutes. This method has been applied for the determination of mercury in 8 USGS standard rocks; the results obtained indicate a precision of ± 10-20%. The homogeneity of the standard samples is discussed. (auth)

2958 SUBSTOICHIOMETRIC EXTRACTION OF CATIONS FROM HCl MEDIA WITH TRI-N-OCTYLPHOSPHINE OXIDE. Mitchell, J. W.; Riley, J. E. Jr. (Bell Labs., Murray Hill, NJ). Radiochem. Radioanal. Lett.; 21: No. 1-2, 41-51(14 Apr 1975).

The feasibility of substoichiometrically extracting cations as neutral salts from aqueous phases of high HCl concentration by solvation with strong oxygen donors has been investigated. Extraction curves for Cd^{2+}, Zn^{2+}, Sb^{3+}, Au^{3+}, Fe^{3+}, Tl^{3+}, Ga^{3+} and Sn^{4+} are reported. Factors limiting the application of this extraction system for substoichiometric separations are discussed. (auth)

2959 DETERMINATION OF VANADIUM IN RAINWATER. Das, H. A.; Gouman, J. M.; Luten, J. B.; de Witte, F.; Wijkstra, J. (Research Reactor Center, Petten, Holland). Radiochem. Radioanal. Lett.; 21: No. 1-2, 61-70(14 Apr 1975).

The routine determination of vanadium in rainwater is described. Two procedures are given. One is applied in the precise analysis of relatively small series. The other is used in the processing of large series of samples, taken in the course of large survey programs. (auth)

2960 USE OF RESONANCE SCATTERING OF CAPTURE GAMMA RAYS AS AN ANALYTICAL TOOL. Suarez, A. A.; Freitas, M. L. (Univ., Campinas, Brazil). Radiochem. Radioanal. Lett.; 21: No. 1-2, 71-78(14 Apr 1975).

The sensitivity for the resonance scattering of capture γ rays was investigated as a tool to measure comparatively small concentrations of certain elements in bulk materials. Looking at the resonance for lead excited by iron capture γ rays it is possible to measure concentrations less than 100 ppM. The advantages of the new technique are compared with other existing methods. The application of nuclear resonance scattering in prospecting for zirconium ores is emphasized. (auth)

2961 RADIOCHEMICAL SEPARATION OF MERCURY FROM BIOLOGICAL MATERIAL. Zmijewska, W. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 21: No. 1-2, 91-97(14 Apr 1975).

A method has been developed for the separation of mercury from neutron-irradiated biological material. The biological material is decomposed by wet combustion in concentrated nitric acid and mercury is separated by extraction with a chloroform solution of thionalide from nitric acid solution (1:3). (auth)

2962 ACTIVATION ANALYSIS OF PLATINUM IN GOLD VIA ^{199}Au. Foerster, H. (VEB Mansfeld-Kombinat Wilhelm Pieck, Freiberg i. B.); Goerner, W. J. Radioanal. Chem.; 24: No. 2, 369-381(1975).

Platinum is determined in gold by activation analysis by means of ^{199}Au after separation of the matrix at the end of irradiation before the daughter nuclide forms. The method involves the radiochemical separation of gold by chloro-complex extraction with MIBK from 1N HCl, and energy-selective pulse counting of ^{199}Au at 158 keV. The irradiation problems are presented. The dependence of the extractability of the gold chloro-complexes on the acidity and the type of solvent are investigated. The procedure of analysis is described. The results obtained in determining 5–700 ppm Pt in Au, Pd and Rh are discussed. (auth)

2963 NEUTRON ACTIVATION SCHEME FOR THE DETECTION AND DETERMINATION OF POLLUTANT HEAVY METALS IN SEWAGE BASED FERTILIZERS. Wiseman, B. F. H.; Bedri, G. M. (North East London Polytechnic). J. Radioanal. Chem.; 24: No. 4, 313-320(1975).

A scheme of analysis of heavy metals in sewage based fertilizers, based mainly on direct gamma spectrometry using a Ge(Li) detector, is described. Reversed-phase anion exchange chromatography was used in separating some of the elements with mutually interfering gamma energies. The results are compared with those obtained from atomic absorption and spectrophotometric procedures. (auth)

2964 POSSIBILITIES AND LIMITS OF ANALYSIS OF BIOLOGICAL SAMPLES BY NEUTRON ACTIVATION BEHIND A CADMIUM FILTER. Application to the Determination of Mo and Ni. Maziere, B.; Gros, J.; Comar, D. (Service Hospitalier Frederic Joliot, Gif-sur-Yvette, France). J. Radioanal. Chem.; 24: No. 2, 279-293(1975). (In French).

The analytical possibilities offered by long-term irradiation of biological samples in a fission neutron flux filtered by a cadmium screen are examined and the preparation of samples for irradiation is described. This specific activation technique is applied to the determination of molybdenum and nickel in the following three reference substances: human serum, NBS bovine liver, and BOWEN's kale. (auth)

2965 SUBSTOICHIOMETRIC DETERMINATION OF COBALT, COPPER, AND MANGANESE IN GLASS AND GLASS-MAKING MATERIALS BY RADIOACTIVATION ANALYSIS. Kudo, K.; Shigematsu, T.; Kobayashi, K.; Iso, H. (Ibaraki Electrical Communication Lab., Japan). J. Radioanal. Chem.; 24: No. 2, 261-269(1975).

A method of radioactivation analysis was developed for the substoichiometric determination of cobalt, copper, and manganese in glass and glass-making materials. The substoichiometric extraction of cobalt with α-nitroso-β-naphthol was studied and simple procedures are suggested for the determination of the three elements. Cobalt is extracted substoichiometrically as α-nitroso-β-naphtholate into chloroform from solution of pH 6.2, copper as dithizonate in carbon tetrachloride from weak acidic solution, and manganese as tetraphenylarsonium permanganate into chloroform after oxidation to permanganate. Contents from 2 ppM to 3 ppB of cobalt, copper, and manganese were analyzed in glass-making materials, and it is shown that the method for their determination is reliable and superior in accuracy and reproducibility. (auth)

2966 ELECTRODEPOSITION ON COPPER POWDER AS A MEANS OF SEPARATION FOR TRACE ANALYSIS OF NOBLE METALS IN ACTIVATION ANALYSIS: A TRACER STUDY. Furler, R.; Licht, I. E. C. P. M.; Offenberg, J. K. L.; Polak, H. L. (Univ. of Amsterdam). J. Radioanal. Chem.; 24: No. 2, 255-260(1975).

A tracer study was performed of the electrodeposition on copper powder of metals with a normal potential above that of the Cu(II)/Cu couple. It appeared that in a quick and simple way nearly complete deposition of palladium, silver, platinum, gold and mercury can be attained, whereas ruthenium, osmium and iridium are hardly deposited. The chemical environment was chosen in such a way [1M and 1.5M nitric acid and Ce(IV)] that problems arising in the application of the system to different matrices are minimized. (auth)

2967 APPLICATION OF INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS TO A STUDY OF PREHISTORIC STEATITE ARTIFACTS AND SOURCE MATERIAL. Allen, R. O.; Luckenbach, A. H.; Holland, C. G. (Univ. of Virginia, Charlottesville). Archaeometry; 17: No. 1, 69-83(Feb 1973).

A study of the trace and minor element content of steatite artifacts from the Eastern United States has been carried out. Samples from both quarry and habitation sites ranging from New York to North Carolina have been analyzed through the use of instrumental neutron activation analysis. The most successful method of evaluating data has involved the study of a very coherent group of elements known as the Rare Earths. Geological processes cause fractionation of this group, and it is this fractionation which is of use in terms of characterizing the source deposits of this material. Promising but less definitive results have been obtained with the elements scandium, chromium, cobalt, and others. Sufficient variations have been found to be present in the source deposits of steatite in this area to enable differentiation, and the successful linking of samples from habitation sites to their quarry deposits has been achieved in some cases. This paper discusses the results of this study to date, the methods employed, and the potential value of this work in helping to reconstruct prehistoric trading systems. (auth)

2968 NEUTRON-ACTIVATION-ANALYSIS INVESTIGATION OF THE DISTRIBUTIONS OF ANTIMONY AND PHOSPHORUS INTRODUCED INTO SILICON BY IONIC IMPLANTATION. Krasivina, L. E.; Zverev, B. P.; Simakhin, Yu. F.; Usmanova, M. M.; Zhumaev, N. (Inst. of Nuclear Physics, Tashkent, USSR). Ind. Lab. (USSR) (Engl. Transl.); 40: No. 10, 1444-1445(Oct 1974).

Translated from Zavod. Lab.; 40: No. 10, 1207-1208(Oct 1974).

The profile distribution of antimony and phosphorus with respect to thickness in crystals was studied by etching thin layers from preactivated specimens. Autoradiography was used to study the uniformity of the impurity distribution over the specimen surfaces. (LK)

2969 THE USE OF THE NUCLEAR MICROPROBE FOR THE EXAMINATION OF NITROGEN DISTRIBUTIONS IN METAL SAMPLES. Olivier, C.; McMillan, J. W.; Pierce, T. B. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Nucl. Instrum. Methods; 124: No. 1, 289-297(15 Feb 1975).

A microanalytical method has been developed for examining distributions of nitrogen in metal samples over the range 0.05 to 2%. Protons and α-particles emitted by the reactions ^{14}N(d,p)^{15}N and ^{14}N(d,α) ^{12}C respectively, are measured in deuteron beams a few micrometers in diameter and are scanned across the sample surface. Good agreement was obtained between nuclear microprobe and chemical analysis when the two techniques were compared. The method has been extended to the examination of radioactive materials. (auth)

2970 THE DENSITY PROFILE OF IMPLANTED ^{3}He MEASURED BY MEANS OF THE ^{3}He(d,p)^{4}He NUCLEAR REACTION.

Hufschmidt, M.; Heintze, V.; Moeller, W.; Kamke, D. (Bochum Univ. (F. R. Germany). Inst. fuer Experimentalphysik). Nucl. Instrum. Methods; 124: No. 2, 573-577(1 Mar 1975).

Density profiles of implanted ^3He atoms in a nickel absorber are determined by detecting the protons from $^3He(d,p)^4He$ while bombarding the absorber with deuterium ions. The density distributions are calculated from the proton-energy spectra by means of a computer program in an absolute scale. It is shown that the results can be used to study diffusion effects. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 3146, 3605, 3613, 3911, and 3953.

2971 (K-1872) EVALUATION OF A QUADRUPOLE MASS SPECTROMETER FOR THE ISOTOPIC ANALYSIS OF URANIUM HEXAFLUORIDE. Jones, H. C. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). Mar 1975. Contract W-7405-eng-26. 9p. Dep. NTIS $4.00.

A quadrupole mass spectrometer was examined for adaptation to the on-stream isotopic analysis of uranium hexafluoride (UF_6) in gaseous diffusion cascades. Source modifications, in conjunction with a molecular beam type inlet system and a liquid nitrogen cold trap, made the quadrupole reasonably compatible with UF_6 at analyzer pressures of not more than 10^{-5} torr. Uranium-235/uranium-238 ratios were measured using automatic peak-switching and integrating circuitry. These measurements indicated that the apparent high resolution of the quadrupole could not be realized with UF_6, due to inadequate sensitivity and low signal-to-noise ratio. After extensive examination of the system, it was concluded that further efforts to adapt the quadrupole to isotopic analysis of UF_6 would be impractical at this stage in quadrupole development. (auth)

2972 DETERMINATION OF Pb(II) AND Sn(IV) BY CHRONOPOTENTIOMETRIC TECHNIQUE. Luniov, M. I.; Kamenev, A. I.; Agasyan, P. K. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 6, 686-689(1974). (In Russian).

The character of E, t curves as a function of value and speed of flow, concentrations of background and element, etc., was studied by a chronopotentiometric technique using the stationary mercury electrode. The data obtained were utilized for the chronopotentiometric determination of lead and tin (in combination with ion exchange separation) in binary alloys with selenium and tellurium. The relative error was found to be less than 5% when concentrations were $n \cdot 10^{-4} M$. (auth)

2973 EXTRACTION OF THIOCYANATE AND PYROCATECHOL NIOBIUM COMPLEXES BY TETRAPHENYLARSONIUM AND TETRAPHENYLPHOSPHONIUM CHLORIDES FROM HYDROCHLORIC ACID SOLUTIONS. Gibalo, I. M.; Lapenko, L. A. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 6, 744-745(1974). (In Russian).

The conditions of formation and extraction of mixed complexes Nb–SCN–TPA(TPP) and Nb–C–TPA(TPP) have been studied. Ratios of components in both ionic associates were found to be Nb : C(SCN) : TPA(TPP) = 1 : 2 : 1. The extraction–photometric method of determination of niobium in the presence of Fe, Ti, Zr, Mo, W, V, and Sn was elaborated and applied to an analysis of alloy No. 309. (auth)

2974 ELECTRON SPECTROSCOPY: PROGRESS IN RESEARCH AND APPLICATIONS. Proceedings of the International Conference Held at Namur, Belgium, April 16–19, 1974. Caudano, R.; Verbist, J. (eds.). Amsterdam; Elsevier Scientific Publishing Company (1974). 1159. (CONF-740429–). $57.50.

Sixty-four papers were presented at the meeting. The discussion topics were: photoelectron spectra of core levels and correlations with other data; surface studies; theoretical models; valence band studies; instrumental and experimental problems; photoelectric cross sections and analytical applications; and photoelectron spectroscopy of gases and liquids. A separate abstract was prepared for one paper. (LK)

For an abstract of an individual paper see: 4421.

2975 A DIRECT CARRIER DISTILLATION PROCEDURE FOR THE SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN URANIUM TETRAFLUORIDE. Dale, L.S. (Australian Atomic Energy Commission, Research Establishment, Lucas Heights, New South Wales, 2232, Australia). Appl. Spectrosc. 28: No. 6, 564-568 (Nov 1974).

A direct carrier distillation procedure for the determination of a wide range of impurities in uranium tetrafluoride is described. The method is based on the use of lead chloride as carrier with yttrium oxide to suppress uranium spectral interference. A deep crater electrode further aids in the reduction of spectral interference. Germanium and cobalt are used as internal standards. The method has been adopted for the simultaneous determination of Ag, Al, B, Cd, Cr, Cu, Fe, Mg, Mn, Mo, Na, Ni, Si, Sn, Ti, V, and Zn with detection limits in the range 0.1 to 20 ppm and coefficients of variation ranging from 4 to 15%. (auth)

2976 DETERMINATION OF TRACES OF MERCURY, MOLYBDENUM, AND ARSENIC IN NATURAL WATER. Kuan, N. W.; Li, N. C. (Peking Univ.). Hua Hseuh Tung Pao; No. 1, 15-19(1974). (In Chinese).

Procedures: Colorimetric determination of Hg—Add to the sample 50% H_2SO_4 soln. (5 ml), H_2O to 100 ml and satd. $KMnO_4$ soln. (2 ml), and set aside for 1 hr. Add 10% hydroxylammonium chloride soln. (2 ml), 2% EDTA soln. (3 ml) and 20% NH_4SCN soln. (1 ml), and extract with 0.002% dithizone in CCl_4 (10 ml) for 1 min. Wash the extract twice with 10 ml of aq. NH_3 (1 : 1) and measure the extinction at 485 nm. Polarographic determination of Mo—To the sample (1 ml) add H_2O (2 ml), 2.5M-H_2SO_4 (4 ml), M-mandelic acid (1 ml) and 50% $NaClO_3$ soln. (5 ml), and record the polarographic wave from 0 to −0.5 V. The calibration graph for the range 1 to 100 parts per 10^9 of Mo is rectilinear. There is no interference from W (0.5 p.p.m.), V (1 p.p.m.) and Cu, Fe and Al (5 p.p.m.). The error is <10%. Polarographic determination of As—Extract the sample (1 ml) plus 0.2% $(NH_4)_2$-MoO_4 in 0.2N-HCl (4 ml) twice with 5 ml of butanol–$CHCl_3$ (2 : 3) to remove PO_4^{3-}, and discard the extracts. To the aq. phase add acetone (0.7 ml) and extract As with butanol–$CHCl_3$–acetone (3 : 7 : 3) (5 ml) for 3 min. Wash the extract with butanol–acetone–aq. HNO_3 (5 ml), then extract the As from the organic phase into M-NaOH (5 ml). To the aq. soln. add 2.5M-H_2SO_4 (2 ml), M-mandelic acid (1 ml) and 50% $NaClO_3$ soln. (5 ml). Deaerate the soln. for 5 min. and record the polarographic wave from 0 to −0.5 V vs. the mercury-pool anode. The calibration graph is rectilinear for the range 0 to 30 parts per 10^9 of As. Recoveries of 20 parts per 10^9 of added As were 84% to 104%. (Anal. Abstr.)

2977 SPECTROPHOTOMETRIC DETERMINATION OF NEPTUNIUM(VI) AND NITRIC ACID IN THE PRESENCE OF EDTA SODIUM SALT. Moiseichenkova, T. I.; Yakovenko, N. P. Zh. Anal. Khim.; 29: No. 12, 2431-2436(Dec 1974). ((In Russian).

The possibility has been shown of measurement of neptunium(IV) and nitric acid concentration by the method of direct two-wavelength spectrophotometry. (auth)

2978 PHOTOMETRIC AND EXTRACTION-PHOTOMETRIC DETERMINATION OF URANIUM(VI) BY MEANS OF ANTIPYRYLAZO COMPOUNDS. Gusev, S. I.; Agilov, V. A.; Shchurova, L. M. (Molotov Medical Inst., USSR). Zh. Anal. Khim.; 29: No. 12, 2427-2430(Dec 1974). (In Russian).

Complex formation was studied between uranium(VI) and 5-(4-antipyrylazo)-2-monoethylamino-p-cresol and 6-(4-antipyrylazo)-3-diethylaminophenol in aqueous ethanol solutions and chloroform extracts. The reagents form with uranium(VI) complexes with a ratio of U : R = 1 : 1. Solvent extraction increases selectivity of determining uranium(IV) by using antipyrylazo compounds. A photometric procedure and an extraction-photometric one are suggested of determining uranium(VI). (auth)

2979 POLAROGRAPHIC CATALYTIC CURRENTS IN SOLUTIONS OF MOLYBDENUM(VI), POTASSIUM CHLORATE, AND GLYCOLIC ACID. Chikryzova, E. G.; Bardina, S. M. (Inst. of Chemistry, Kishinev). Zh. Anal. Khim.; 29: No. 12, 2414-2419(Dec 1974). (In Russian).

Glycolic acid (L) activates catalytic current in acid solutions containing Mo(VI) and $KClO_3$. It is suggested that a mixed intermediate active complex $Mo(V)KClO_3^-$ is formed. A series of reactions is suggested, which proceed in the solution and at the electrode. The volume nature of the reaction of forming the intermediate is shown. The effect of isoamyl and isobutyl alcohol, gelatin and agar-agar (a surface-active substance) has been studied on the catalytic current. Agar-agar activates the catalytic current while other surface-active substances suppress it. Molybdenum(VI) can be determined in solution by its catalytic current. A monocarboxylic hydroxy acid has been quantitatively determined from the catalytic current. The possibility was shown of detecting the surface-active substances studied and their quantitative determination in solution. (auth)

2980 COMPARATIVE ESTIMATION OF 8-HYDROXYQUINOLINE AND ITS DIHALODERIVATIVES AS REAGENTS FOR EXTRACTION-PHOTOMETRIC DETERMINATION OF RARE EARTHS IN THE FORM OF ION ASSOCIATES WITH RHODAMINE B. Mishchenko, V. T.; Lomakina, E. G.; Tselik, E. I.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim.; 29: No. 12, 2396-2401(Dec 1974). (In Russian).

Spectrophotometric characteristics are compared of ion associates of Nd^{3+} and Er^{3+} with 8-hydroxyquinoline and its 5,7-dichloro-, 5,7-dibromo-, 5,7-diiododerivatives (DIHQ) and rhodamine B. Maximum value of ϵ is obtained in chloroform extracts of ion associates of rare earths involving DIHQ. The component

ratio in the ion associates has been determined to be Me^{3+} : DIHQ: rhodamine B = 1 : 1 : 1. A high-sensitive extraction-photometric procedure was developed of determining rare earths. (auth)

2981 METHODS OF SEPARATION, CONCENTRATION, AND DETERMINATION OF CERIUM. Kharlamova, L. I.; Borcheva, T. A.; Solomatin, V. T. (Bardin Inst. of Central Scientific-Research of Metallurgy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 40: No. 10, 1393-1403(Oct 1974).

Translated from Zavod. Lab.; 40: No. 10, 1169-1177(Oct 1974).

Extraction and chromatographic methods for separation of cerium are discussed. The following methods of determination are reviewed: photometric, electrochemical, gravimetric, and titrimetric. (134 references) (LK)

2982 KINETIC METHOD FOR DETERMINATION OF NICKEL IMPURITY IN RARE-EARTH METAL OXIDES. Yurikova, L. P.; Dzhumashev, A. Ind. Lab. (USSR) (Engl. Transl.); 40: No. 10, 1431-1432(Oct 1974).

Translated from Zavod. Lab.; 40: No. 10, 1197(Oct 1974).

Nickel impurity in lanthanum and yttrium oxides was determined by a kinetic method by means of the catalytic oxidation of tiron–diphenylcarbazone–hydrogen peroxide. By using this method it is possible to determine $1 \cdot 10^{-6}$% nickel. (LK)

2983 INDUCTIVELY COUPLED PLASMA–OPTICAL EMISSION SPECTROMETRY: APPLICATION TO THE DETERMINATION OF ALLOYING AND IMPURITY ELEMENTS IN LOW AND HIGH ALLOY STEELS. Butler, C. C.; Kniseley, R. N.; Fassel, V. A. (Ames Lab., IA). Anal. Chem.; 47: No. 6, 825-829(May 1975).

Three different inductively coupled plasma–optical emission spectrometry (ICP–OES) systems have been used for the determination of residual impurities and alloying constituents in solutions of high and low alloy steels of widely varying composition. The results of these studies show that the presence of an iron matrix does not influence the detection limits for the 12 elements studied and that these elements can be determined at fractional ppm levels without prior chemical concentration. The analytical calibrations were established with synthetic reference solutions and the resulting analytical curves exhibited linearity over three to four orders of magnitude. The relative standard deviations determined over an extended period of time ranged from approximately 0.01 to approximately 0.07. (auth)

2984 SPECTROPHOTOMETRIC DETERMINATION OF TRACE QUANTITIES OF IODIDE AFTER SEPARATION FROM LARGE QUANTITIES OF BROMIDE, CHLORIDE, OR SULFATE BY SOLVENT EXTRACTION. Chadwick, T. C. (Consolidated Foods Corp., Santa Maria, CA). Anal. Chem.; 47: No. 6, 933-936(May 1975).

Iodide solutions were reacted with 2,4,6-triphenylpyrylium bisulfate to yield the triphenylpyrylium iodide which was extracted with chloroform and spectrophotometrically determined. The interference from perchlorate, bromide, chloride, and sulfate ions on the iodide determination was evaluated. An analytical procedure for the determination of iodide present as the iodate was developed using sodium sulfite to reduce the iodate to iodide. The use of this method for the determination of KI in commercial iodized salt gave results comparable to those obtained by the AOAC iodometric method. (JSR)

2985 QUANTITATIVE ANALYSIS OF UNLABELLED AND POLYDEUTERATED COMPOUNDS BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY. Axelson, M.; Cronholm, T.; Curstedt, T.; Reimendal, R.; Sjoevall, J. (Kungliga Karolinska Mediko-Kirurgiska Institutet, Stockholm (Sweden). Dept. of Chemistry). Chromatographia; 7: No. 9, 502-509(Sep 1974).

A system for computer evaluation of gas chromatographic–mass spectrometric analyses of unlabelled and polydeuterated compounds is described. The system has been in routine use for two years and was found to fulfil most of the needs of the laboratory in connection with studies of steroid and bile acid metabolism. Complete or partial spectra are taken by repetitive magnetic scanning and are recorded on magnetic tape. Quantitative determinations of unlabelled compounds are based on areas of gas chromatographic peaks in selected specific fragment ion current chromatograms generated by the computer. Percentage distribution of molecular or fragment ion species containing 0 to 19 deuterium atoms is calculated from averaged spectra by comparison with spectra of the unlabelled reference compound analyzed on the same day. When small amounts of material are available and when ions occur in low abundance, repetitive accelerating voltage scanning over a short mass range is used. A slow scan rate, 1-5 s, and a high data sampling rate, 10 kHz, permit a 100-300 fold increase of amplification. After bunching of intensity readings, partial mass spectra are constructed which are treated in the same way as complete spectra. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 3114, 3511, and 3537.

2986 (AD/A-002065) X-RAY FLUORESCENCE ANALYSIS OF YTTRIUM–IRON–GADOLINIUM SOLUTIONS USED TO PREPARE SPRAY DRIED POWDERS. Magathan, E. M.; Short, D. W.; Yocom, R. L. (Army Missile Command, Redstone Arsenal, Ala. (USA)). Sep. 1974. 47p. (QL-TR-74-3). NTIS $3.75.

The purpose of this study was to develop an analytical quality control test method capable of monitoring the yttrium-iron-gadolinium ternary feedstock solutions used to produce phase shifter toroid powders for a planned radar system (SAM-D). An analytical quality control procedure using x-ray secondary emission spectrometry has been developed to monitor iron, yttrium, and gadolinium metal ion ratios in binary and ternary nitric acid feedstock solutions. These feedstock solutions are used to produce spray dried ferrimagnetic powders meeting specifications for ferrite and garnet elements used in microwave components. (GRA)

2987 (ARH-SH-187) DIRECT GAMMA SPECTROMETRIC DETERMINATION OF AMERICIUM-241 IN FRESHLY PROCESSED PLUTONIUM SOLUTIONS. Hartwell, J. K. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1974. Contract AT(45-1)-2130. 32p. (CONF-740636-3). Dep. NTIS $4.75.

From meeting of the American Chemical Society; Cheney, Washington, USA (13 Jun 1974).

Operation of a plutonium separation facility requires rapid and accurate determination of the ^{241}Am content of the process streams and the final product solution. Most literature methods for the direct gamma spectrometric determination of ^{241}Am in plutonium either require access to a computer or are not applicable to freshly processed solutions due to a contribution from ^{237}U to the 59.54 keV gamma peak. A rapid, accurate method for analysis of ^{241}Am in plutonium solutions using a Ge(Li) spectrometer is described. Correction for the ^{237}U contribution to the 59.54 keV peak is made by monitoring the 208.0 keV peak, which is specific for ^{237}U. The method requires no separation and is applicable to materials of any age. (auth)

2988 (BNWL-SA-5338) EVALUATION OF DOUBLE SAMPLING FOR ESTIMATING PLUTONIUM INVENTORY IN SURFACE SOIL. Gilbert, R. O.; Eberhardt, L. L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 12 May 1975. Contract AT(45-1)-1830. 22p. (CONF-750503-13). Dep. NTIS $4.25.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

The Nevada Applied Ecology Group (NAEG) is currently obtaining estimates of the total amount (inventory) of $^{239-240}Pu$ in surface soil using stratified random sampling at a number of "safety-shot" locations on the Nevada Test Site (NTS) and the Tonopah Test Range (TTR). Since radiochemical analyses for plutonium are costly and large numbers of samples are usually required, the usefulness of double sampling in combination with stratified random sampling for estimating plutonium inventory was investigated. A less costly method of analysis is used to estimate plutonium concentrations using a linear regression relationship between the two variables. The regressions of $^{239-240}Pu$ concentrations on the following auxiliary variables are considered: (1) Ge(Li) scans for ^{241}Am on soil samples brought to the laboratory, and (2) FIDLER (Field Instrument for the Determination of Low Energy Radiation) net 60 keV counts per minute (cpm) readings of ^{241}Am taken in the field. Data from two NTS safety-shot sites (Project 57 in Area 13 and GMX site in Area 5) indicate that except for the lower plutonium concentration zones, the use of either Ge(Li) scans or FIDLER counts in conjunction with $^{239-240}Pu$ radiochemical analyses can yield estimates of inventory with greater precision than possible with plutonium analyses alone. Percentage reductions in standard errors up to 35 percent using Ge(Li) scans and up to 45 percent using FIDLER counts appear to be possible with no increase in total costs. Also, the data suggest that double sampling will supply standard errors equal to those being obtained using only plutonium analyses at cost savings of 20 to 30 percent. (auth)

2989 (EMR-IC-310) X-RADIOMETRIC ASSAYING IN THE MINING OF MOLYBDENUM–WOLFRAM ORES. Leman, E. P. (Leningradskij Gornyj Inst. (USSR)). Oct 1973. Translated from Russian. 9p. INIS.

A technique is suggested to determine tungsten and molybdenum in ores by use of the L-series characteristic of the x radiation of tungsten (8.5 keV) and the K-series of molybdenum (17.5 keV); these are simultaneously and efficiently excited by the isotope ^{109}Cd (22.5 keV) and are detected by a xenon proportional counter. Advantages over previous methods are the use of a single analyzer, simultaneous determination of both elements and speed of analysis. (INIS)

2990 (NLCO-1084) RADIOMETRIC DETERMINATION OF ^{226}Ra AND ^{228}Ra IN WASTE EFFLUENT SOLUTIONS. Humphrey, H. W.; Adkins, E. L.; Templin, G. G. (National Lead Co. of Ohio, Cincinnati (USA)). Apr 1975. Contract AT(30-1)-1156. 21p. Dep. NTIS $4.00.

An analytical method was developed which permits the determination of ^{226}Ra and ^{228}Ra in production by-product streams to a low detection limit of 0.010 d/m/ml. The method provides for the separation of the only two long-lived isotopes of radium from effluent solutions containing uranium and thorium (plus their respective decay products), as well as many nonradioactive materials. The radium isotopes are isolated from acid soluble contaminants using a nitrate precipitation followed by passage through cation exchange columns for final purification and separation of the nuclides to be assayed. ^{226}Ra levels are determined by measuring the 4.78 MeV alpha particles (emitted 95 per cent of the time) after making appropriate corrections for both volumes and recovery. ^{228}Ra concentrations are determined indirectly by measuring the more energetic beta emissions of its daughter ^{228}Ac after it has been permitted to grow back into a purified ^{228}Ra fraction. Corrections are made for volumes and recovery as well as growth and decay times. Three different levels of ^{226}Ra and ^{228}Ra in process effluents were evaluated to determine the precision of the technique. (auth)

2991 EVALUATION OF PRECISION OF RADIOMETRIC MEASUREMENTS IN THE PRESENCE OF ADDITIONAL SOURCES OF RANDOM ERRORS. Luk'yanov, V. B.; Simonov, E. F. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 6, 711-714(1974). (In Russian).

When performing radiometric measurements it is possible to consider three cases depending on the specific features of experimental operations and on the relative contribution of errors connected with the different sources of dispersion. In these cases the scattering of results is characterized as follows: (1) by quadratic deviation the magnitude of which does not depend on the average value of the measuring parameter, (2) by quadratic deviation the magnitude of which depends on the average value of the measuring parameter and (3) by dispersion of Poisson's distribution. Choice of a model for treatment of results of radiometric measurements is suggested to perform on the basis of the pair correlation coefficients $r\{\bar{y}_i, S_i\}$ and $r\{\bar{y}_i, S_i^2\}$ where $\bar{y}_i$ is the average value of output parameter for the-ith value of independent variable and S_i^2 is the corresponding selective dispersion. The data are given which demonstrate the suggested method for treatment of experimental results. (auth)

2992 INCREASE IN SENSITIVITY OF DETERMINATION OF SOME LANTHANIDES IN LANTHANUM OXIDE USING CRYSTALLINE PHOSPHORS BASED ON LaOCl WITH ACTIVATION BY X RAYS. Efryushina, N. P.; Poluektov, N. S.; Smirdova, N. I. (Inst. of General and Inorganic Chemistry, Odessa). Ukr. Khim. Zh.; 41: No. 1, 81-84(Jan 1975). (In Russian).

The luminescence spectra due to x-ray activation of lanthanide ions in crystalline phosphors based on LaOCl were studied. It was shown that the luminescence of Pr, Sm, Dy, and Tl ions was greater than that produced by a mercury lamp radiation and may be used for increasing the sensitivity of the determination of these ions 1 to 1.5 fold. Several samples of La_2O_3 were analyzed and the results of the analysis were treated statistically. (tr-auth)

2993 OPTICAL AND MASS-SPECTROSCOPIC METHODS. Winge, R. K.; Fassel, V. A. (Iowa State Univ., Ames). pp 265-287 of Determination of Gaseous Elements in Metals. Melnick, L.; Lewis, L.; Holt, B. New York; John Wiley and Sons, Inc. (1974).

The following methods for determining H, N, and O in metals are discussed: emission spectroscopy (spark and impulse discharges, dc arc, and discharge tube excitation); mass spectroscopy; and isotopic techniques (isotope dilution, isotope balancing, or isotope exchange). (LK)

2994 ISOTOPE DILUTION METHOD FOR ENVIRONMENTAL LEAD DETERMINATIONS. Branquinho, C. L.; Robinson, V. J. (Universidade Federal do Rio de Janeiro). J. Radioanal. Chem.; 24: No. 2, 321-326(1975).

A method is described for the use of ^{212}Pb to measure overall recovery in lead analyses. Other modifications of published procedures are also outlined. Most difficulties occur with samples containing small amounts (< 10 μg) of Pb. In addition to low recovery factors, spectra are often obscured by the presence of dithizone oxidation product: a procedure for dealing with this is given. (auth)

2995 SPIKING ISOTOPE DILUTION. Das, H. A.; Koehnemann, H.; van der Mark, W. (Reactor Centrum Nederland, Petten). J. Radioanal. Chem.; 24: No. 2, 383-392(1975).

The isotope dilution method, which is based on the isolation of a constant substoichiometric amount, can be completed by a group of radiometric techniques in which this amount is a function of the concentration to be determined. It is convenient then to plot the experimental data in such a way that a straight line is obtained. The methods which can be used in the application of this principle are discussed, mathematically treated and compared to the original procedure of RŮZICKA and STARÝ. Expressions are derived for the relative statistical error and the limit of detection. (auth)

2996 USE OF RADIOISOTOPE INDUCED X-RAY FLUORESCENCE FOR ENVIRONMENTAL STUDIES. Kulkarni, P. V.; Preiss, I. L. (Rensselaer Polytechnic Inst., Troy, NY). J. Radioanal. Chem.; 24: No. 2, 423-432(1975).

The rapid assay of the trace multi-element content of environmental samples (lake sediment) is described. The method utilized x-ray fluorescence induced by a ^{109}Cd radioisotopic source with energy dispersive quantitative detection of the characteristic x-rays of nine elements, ranging from Ti to Zr using Si(Li) semiconductor detector. The method precludes pre-digestion or chemical treatment of the samples, and compairs favorably with the results of atomic absorption assay methods. (auth)

2997 AUTOMATIC WASHING OF A NUMBER OF SAMPLES. Reunanen, M. British Patent 1,372,238/B/. 30 Oct 1974. 7p.

Apparatus is described with which a large number of samples can be simultaneously and automatically worked free of undesired substances. The desired components are absorbed into sheets of absorbent material, the sheets are placed in a washing tank, with liquid flow paths between them, working liquid is passed through the flow paths, and air is passed through the washing tank to remove washing liquid from the sheets and to dry them. Valves are provided for automatic operation, together with pumps and thermostats. Agitators may also be provided. The apparatus is stated to be suitable for preparing samples for radioactive measurements. (UK)

2998 SEPARATION OF KI AND KIO_3 USING 1,4-DIOXANE. Hull, D. R.; Owens, C. W. (Univ. of New Hampshire, Durham). Radiochem. Radioanal. Lett.; 21: No. 1-2, 39-40(14 Apr 1975).

A simple and quick procedure was elaborated for the separation of KI and KIO_3 and subsequent scintillation counting. (auth)

2999 NON-DESTRUCTIVE GAMMA SPECTROMETRY MEASUREMENT OF $^{239}Pu/^{240}Pu$ AND $Pu/^{240}Pu$ RATIOS. Dragnev, T.; Schaerf, K. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isot.; 26: No. 3, 125-129(Mar 1975).

A new nondestructive γ spectrometry technique for the measurement of $^{239}Pu/^{240}Pu$ and $Pu/^{240}Pu$ ratios was developed by determining the intensity ratio of the 645.9-keV line of ^{239}Pu to that of the 642.3-keV γ line of ^{240}Pu. The main advantages of this technique are: (i) the high penetration power of those γ rays and (ii) the fact that their energies are very close together. Therefore, this method can be applied for all kinds of unirradiated samples with a Pu content of 1 g or more. The technique was checked in a rather wide range of Pu samples with different chemical and isotopic compositions and weights. The experiments demonstrated that it is possible, using this technique, to determine the $^{239}Pu/^{240}Pu$ isotopic ratio with an accuracy of the order of 1%. (auth)

3000 DIFFERENCES IN THE RADIOCHEMICAL DETERMINATION OF AMERICIUM AND CURIUM BY THE GLASS FIBRE FILTER PAPER METHOD. Crawley, F. E. H. (National Radiological Protection Board, Harwell, Eng.). Int. J. Appl. Radiat. Isotop.; 26: No. 3, 137-138(Mar 1975).

A method devised by Eakins et al. [Health Phys 14: 461 (1968) and UKAEA Rep. AERE-R 7014 (1972)] for the bioassay of ^{241}Am in urine by adsorption onto glass fiber filter paper has been modified in order to determine both actinides in various biological samples. Full experimental details of the modifications are given. This low ash content method was investigated using samples of kidney and adrenal. Recoveries of both ^{243}Am and ^{244}Cm were in the range 50 to 70% with no difference between the two actinides. Results for this method and from the high ash content method are compared. (UK)

3001 RADIOMETRIC DETERMINATION OF BISMUTH IN ITS ALLOYS WITH ANTIMONY, TIN, AND LEAD. Shamaev, V. I.; Sichkar, G. A. (Moscow Chemicotechnological Inst.). Zh. Anal. Khim.; 29: No. 12, 2408-2413(Dec 1974). (In Russian).

A procedure was developed of determining bismuth in antimony, tin, lead, and their alloys using preliminary separation. The radiometric correction method was used for this purpose. It involves substoichiometric extraction with a cupferron chloroform solution. The error is not more than 4%. The procedure is recommended for analysis of alloys containing bismuth to the extent of 1% and more. To determine small amounts (from percent fraction to several percent) of bismuth, a procedure was developed based on the radiometric method of calibration curves using

substoichiometric extraction of the cupferronates with chloroform. This procedure was used for analysis of bismuth-antimony and bismuth-tin alloys containing tenths percent of bismuth, the error being not greater than 5%. (auth)

3002 QUANTITATIVE DETERMINATION OF RADIOACTIVE ISOTOPES IN REACTOR POOL WATER. Teitelbaum, R. C.; Anderson, J. M.; Mancuso, R. V.; Palmer, R. (SUNY Coll., Brockport, NY). Health Phys.; 28: No. 3, 301(Mar 1975).

The quantitative determination of ^{51}Cr, ^{54}Mn, ^{58}Co, ^{60}Co, ^{103}Ru, ^{110}Ag, ^{121}Te, ^{124}Sb, ^{140}Ba, ^{141}Ce, and ^{239}Np in reactor pool water is reported. The isotopes were produced by neutron activation and fission; the fission products are the result of the failure of the cladding on a fuel pin in January 1971. The method of production, the activity in μCi/ml on Oct. 6, 1972, and the ratio of activity to MPC × 100%, for each isotope are tabulated. (UK)

3003 ELEMENTAL TRACE ANALYSIS OF SMALL SAMPLES BY PROTON INDUCED X-RAY EMISSION. Johansson, T. B.; Van Grieken, R. E.; Nelson, J. W.; Winchester, J. W. (Florida State Univ., Tallahassee). Anal. Chem.; 47: No. 6, 855-860(May 1975).

Quantitative analysis of 12 to 15 elements simultaneously by proton-induced x-ray emission, PIXE, has been tested for thin small inhomogeneous samples such as impactor collected aerosol size fractions using a low energy, 3.7-MeV, proton beam from a Van de Graaff accelerator. The procedure and a number of tests of the performance of the system and the analytical methodology are presented. Detection limits for multielement samples in a 10-min bombardment are in the nanogram range, and standard deviations are as low as 6 percent for analyses of homogeneous samples and 15 percent for heterogeneous samples. The method is calibrated to be absolute in the sense that standards are needed only to check the stability of the system. (auth)

Separation Procedures

Refer also to abstracts 3041, 5314, and 5678.

3004 (ICP-1057) 1974 OPERATION OF THE ICPP RARE GAS RECOVERY FACILITY. Bendixsen, C. L.; German, F. O. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs-Operations Office). Mar 1975. Contract AT(10-1)-1375. 17p. Dep. NTIS $4.00.

Operation of the Rare Gas Recovery Facility at the Idaho Chemical Processing Plant during CY-1974 resulted in the recovery of 43,100 curies of krypton-85 and 3,780 liters of xenon from off-gas produced during dissolution of spent nuclear fuel elements. Overall operation was generally very good with recovery efficiencies for krypton and xenon being 52 and 63 percent respectively. (auth)

3005 (NP-20316) RECOVERY OF URANIUM FROM PHOSPHORIC ACID. Adalid, J. M. A. (Universidad Veracruzana, Orizaba (Mexico). Facultad de Ciencias Quimicas). 1974. 87p. (In Spanish). Dep. NTIS (US Sales Only) $7.50.

Thesis.

Uranium was extracted from solutions of 4 and 6M phosphoric acid with iso-octyl phosphoric ester diluted with kerosene. Sixty percent phosphoric acid was used as re-extractant in an intermediate step and concentrated ammonium carbonate (2M) was used as the re-extractant in the final step. A procedure was evaluated for the recovery and concentration of U contained in phosphoric acid solutions at concentrations from 0.05 to 0.50 g of U_3O_8/l of acid and at concentrations five and six times stronger. The iso-octyl phosphoric ester probably shows the best possibilities with respect to its U extraction capacity for the solutions of phosphoric acid studied with an efficiency of 90 to 95%. (tr-auth)

3006 (RFP-Trans-166) SYNERGISM IN LIQUID-LIQUID EXTRACTION. Madic, C. 1972. Translation of CEA-CONF-2631. 18p. Dep. NTIS $4.00

As an introduction the general features of liquid-liquid extraction are summarized. The phenomenon of synergism in solvent extraction is defined, taking into consideration both positive and negative synergism. As an example of synergistic effects, the solvent extraction properties of TTA with neutral and cationic exchangers, the parameters affecting synergism in solvent extraction, and negative synergism and antagonistic phenomena with TTA are analyzed. Examples of the use of the synergistic effect in analytical and industrial applications are briefly reviewed. (JSR)

3007 DISTRIBUTION COEFFICIENTS FOR 52 ELEMENTS IN HYDROCHLORIC ACID-WATER-ACETONE MIXTURE ON DOWEX 1 × 8. Petters, J. M.; del Fiore, G. (Univ., Liege). Radiochem. Radioanal. Lett.; 21: No. 1-2, 11-21(14 Apr 1975).

Results of a systematic study on the adsorbabilities of 52 elements in HCl (1.2M)-water-acetone media on Dowex 1 × 8 anionic resin are reported. Some aspects, in regard to aqueous hydrochloric acid medium, are discussed. (auth)

3008 BEHAVIOUR OF TRIVALENT PLUTONIUM DURING ITS EXTRACTION BY THENOYLTRIFLUOROACETONE. Hubert, S.; Hussonnois, M.; Guillaumont, R. (Univ., Paris). J. Inorg. Nucl. Chem.; 37: No. 5, 1255-1258(May 1975). (In French).

Direct solvent extraction and stripping of trivalent plutonium have been investigated in the system: perchlorate hydroxylamine aqueous solutions/thenoyltrifluoracetone (TTA)-benzene as a function of C_{pu}, C_{TTA} and pH. Mononuclear hydrolysis of Pu^{3+}_{aq} starts as soon as pH ~4 and the extraction with TTA is very high; such a behavior is not expected from data about its neighbors Am(III) to Es(III). (auth)

3009 PREPARATION AND SORPTION PROPERTIES OF ZIRCONIUM PHOSPHATE SPHERICAL PARTICLES. Ullrich, J.; Tympl, M.; Pekarek, V.; Vesely, V. (Nuclear Research Inst., Rez, Czech.). J. Radioanal. Chem.; 24: No. 2, 361-368(1975).

Spherical particles of zirconium phosphate ion-exchanger have been prepared by the conversion of hydrous zirconia prepared by the sol-gel method. Some physicochemical properties, stabilities, and sorptions of 1-4-valent cations have been studied and compared with those of amorphous zirconium phosphate powder. (auth)

3010 SYNERGISTIC EXTRACTION OF RADIUM USING 2-THENOYLTRIFLUOROACETONE AND TRIBUTYL PHOSPHATE OR TRIOCTYLPHOSPHINE OXIDE. Sebesta, F.; Havlik, B. (Technical Univ. of Prague). J. Radioanal. Chem.; 24: No. 2, 337-343(1975).

The extraction of radium into a mixture of 2-thenoyltrifluoroacetone (HTTA) and tributyl phosphate (TBP) or trioctylphosphine oxide (TOPO) in n-hexane or cyclohexane has been investigated with regard to the dependence on pH, and TBP and TOPO concentrations. It has been found that the formation of mixed complexes of the type $Ra(TTA)_2(TBP)_2$ and $Ra(TTA)_2(TOPO)_2$ occurs and the overall extraction constants of both complexes were calculated. With the systems described, very high distribution ratios of radium have been attained; these may advantageously be used for the separation and concentration of traces of radium. (auth)

3011 FAST SEPARATIONS OF YTTRIUM, SILVER, BROMINE, AND IODINE IN HEAVY-ION-INDUCED FISSION. Freeman, J. E.; Newton, G. W. A.; Robinson, V. J. (Univ. of Manchester, Eng.). J. Radioanal. Chem.; 24: No. 2, 433-435(1975).

Fast separation methods were devised for short-lived fission products embedded in Mg catcher foils; these are based on solvent extraction techniques. ^{34}Cl is a major contamination problem beacuse it is formed directly by spallation in the catcher foil. The methods for Ag, Br, and I had a decontamination factor of >1000:1 for this isotope. (auth)

3012 DISTRIBUTION EQUILIBRIA OF $SmCl_3-EuCl_3-HCl$ AND $EuCl_3-GdCl_3-HCl$ SYSTEMS WITH 1M DI(2-ETHYLHEXYL) PHOSPHORIC ACID IN N-HEPTANE. Hirashima, Y.; Mugita, M.; Shiokawa, J. (Osaka Univ.). J. Inorg. Nucl. Chem.; 37: No. 5, 1249-1253(May 1975).

Distribution equilibrium data have been obtained for the systems $LnCl_3-HCl-H_2O$-1M D2EHPA in n-heptane (Ln: Sm, Eu and Gd). The equilibrium curves were described using equilibrium acid concentration as a parameter. It was shown that the distribution ratios of the lanthanides were proportional to C^{-2}_{HX} or C^{-3}_{HX} (C_{HX} represents the concentration of the extractant) according to the estimated value for the ratio of the extractant to the metal in the extracted species. Equilibrium data for the systems involving $SmCl_3-EuCl_3$ and $EuCl_3-GdCl_3$ have been obtained. In these systems the concentrations of individual lanthanides in the organic phase deviated from the expected values based on the assumption that the distribution ratio of each lanthanide was not varied by adding the other lanthanides. The concentrations of the heavier lanthanides, Eu in Sm-Eu system and Gd in Eu-Gd system, in the organic phase were higher than the expected values, and those of the lighter lanthanides were lower than the expected values. These behaviors of the lanthanides were explained in terms of the change of the concentrations of the hydrogen ion and the extractant. (auth)

3013 PRECIPITATION OF MOLYBDENUM(V) AS THE HYDROXIDE AND ITS SEPARATION FROM RHENIUM. Yatirajam, V.; Ahuja, U.; Kakkar, L. R. (Kurukshetra Univ., India). Talanta; 22: No. 3, 315-317(Mar 1975).

A study of the conditions for precipitation of molybdenum(V) hydroxide shows that for Mo concentrations ≥ 1 mg/ml about 97.5% of the Mo can be precipitated between pH 5 and 5.8. Lower concentrations of molybdenum(V) or molybdenum(VI) can be

precipitated quantitatively by using 20 times the amount of zirconium as collector, at the same pH. On this basis, a simple method is given for quantitative separation of rhenium from large amounts of molybdenum and is attested by analysis of synthetic and molybdenite samples. (auth)

3014 IMPROVEMENTS IN OR RELATING TO ELECTROCHEMICAL PROCESSES AND APPARATUS THEREFOR IN WHICH COUNTERCURRENT TWO PHASE FLOW IS COMBINED WITH ELECTROLYTIC REDUCTION OR OXIDATION. Baxter, W.; Naylor, A.; Smith, W.; Warner, B. F. (to United Kingdom Atomic Energy Authority). British Patent 1,366,877/B/. 11 Sep 1974. Filed Date 23 Nov 1970. 6p.

The process described, although of general application, is stated to be particularly applicable to the separation of U and Pu (see British Patent 1,264,921). It is based on solvent extraction coupled with electrolytic reduction of the Pu from Pu(IV) to Pu (III) during extraction. The liquid-liquid contactor used may comprise a mixer-settler that includes an electrochemical cell having an electrode consisting of a bed of conducting particles comprising glass beads coated with a metal such as Au, Pd, or Cu, or SiC spheres coated with C. It is arranged that the mixed liquid phases in the contactor are forced to flow through the conducting bed. The electrochemical cell may be located between the mixer compartment and the settler compartment of the mixer-settler unit, or within the mixer compartment. With the latter arrangement, mixing of the phases may be achieved by pulsing, which serves also to force the mixed phases through the electrode bed; alternatively the contactor may comprise a pulsed column. (UK)

3015 SORPTION OF BERYLLIUM, ZINC, AND CADMIUM FROM $MeF_2-NaF(KF)-H_2O$ SOLUTIONS BY KU-2 × 8 CATION-EXCHANGE RESIN. Pakholkov, V. S.; Zelenkov, B. N. J. Appl. Chem. USSR (Engl. Transl.); 47: No. 10, 2271-2274(Oct 1974).

Translated from Zh. Prikl. Khim.; 47: No. 10, 2213-2216(Oct 1974).

Study of sorption and desorption of beryllium, zinc, and cadmium from solutions of their fluorides by KU-2 × 8 resin in H^+ form, in relation to the NaF and KF concentrations, showed that while beryllium, zinc, and cadmium are eluted easily and completely by 0.1-1.0 N NaF solutions ions of the alkaline-earth metals are not eluted at all from KU-2 × 8 resin. Differences in the behavior of zinc and cadmium ions during elution from the cation-exchanger by 1 N potassium fluoride solution were used for separating these elements. It was shown with the aid of x-ray-phase analysis that dispersed precipitates or insoluble salts and simple fluorides of alkaline-earth elements are formed in the resin phase by interaction of the ions with the eluant solution. (auth)

3016 APPLICATION OF DESIGN OF EXPERIMENTS TO A STUDY OF SEPARATION OF SCANDIUM FROM TITANIUM. Granovskii, Yu. V.; Komissarova, L. N.; Krivenko, S. V.; Kalinin, V. B.; Shatskii, V. M. (Moscow State Univ.). J. Appl. Chem. USSR (Engl. Transl.); 47: No. 10, 2319-2322(Oct 1974).

Translated from Zh. Prikl. Khim.; 47: No. 10, 2261-2265(Oct 1974).

The conditions for separation of scandium from titanium by sorption on cellulose phosphate from sulfuric acid solutions were studied, and a high degree of scandium extraction (92%) was achieved, with fairly effective separation: the separation factor was 20. As the result of analysis of mathematical models of the process and of sections of the response surface, certain hypotheses of the mechanism of scandium sorption were put forward and verified. (auth)

3017 DISTRIBUTION CONSTANTS AND THE FORMATION OF URANIUM CHROMATOGRAPHIC BANDS ON COLUMNS WITH ION EXCHANGERS IN THE WATER–GLYCERINE SYSTEM. Murgulescu-Dragoi, S. Rev. Chim. (Bucharest); 26: No. 1, 31-35(Jan 1975). (In Rumanian).

The distribution constants of U(VI) in the water–glycerine system on Vionit CS 3 resin are determined in order to find out the optimum pH conditions for obtaining net uranium bands. The profile of uranium bands for different glycerine and acetic acid concentrations are then studied. (auth)

3018 EXTRACTION AND SEPARATION STUDIES OF CHROMIUM(VI) FROM NITRIC ACID SOLUTIONS USING 4-(5-NONYL)-PYRIDINE. Iqbal, M.; Ejaz, M. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). Anal. Chem.; 47: No. 6, 936-940(May 1975).

The use of 4-(5-nonyl)pyridine in benzene solutions for the solvent extraction of trace and weighable quantities of Cr from nitric acid solutions of U and some fission products was studied using tracer techniques. The effects of the concentration of HNO_3, pyridine, and Cr on the efficiency of the Cr extraction were determined. High HNO_3 concentrations had a detrimental effect. The effect of various anions and reducing agents was also determined. It is possible to back-extract macroamounts of Cr from the solvent phase with very low acid concentrations. The extraction mechanisms were discussed briefly and distribution coefficients were tabulated. (JSR)

3019 COMPLEX FORMATION OF RARE EARTH ELEMENTS WITH NITRATE MELTS. I. Co-Crystallization of Microquantities of Promethium with Strontium Nitrate. Kryukova, A. I.; Kolysh A. V.; Korshynov, I. A.; Veselova, N. A.; Toropova, N. I. pp 67-71 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

In recent years many studies have been made on the separation of rare earths from nitrate melts of the alkaline earth metals. In the present study the co-crystallization coefficients of Pm with $Sr(NO_3)_2$ from nitrate melts were determined for the following systems: $Sr(NO_3)_2(Pm)-LiNO_3$ and $Sr(NO_3)_2(Pm)-NaNO_3$ at 310, 330, and 350°C and $Sr(NO_3)(Pm)-LiNO_3-NaNO_3$ at 290 and 310°C with liquid phase compositions containing 60, 55, 30, and 15 mol % $LiNO_3$. The dependence of the co-crystallization coefficients on the temperature and the composition of the liquid phase was established. (tr-auth)

3020 COMPLEX FORMATION OF RARE EARTH ELEMENTS WITH NITRATE MELTS. II. Study of the Complex Formation of Praseodymium by Methods of Physical-Chemical Analysis. Kryukova, A. I.; Kolysh, A. V.; Korshunov, I. A.; Veselova, N. A. pp 71-74 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The crystallization temperature dependence–composition curves were studied in the systems $Pr(NO_3)_3-LiNO_3$ and $Pr(NO_3)_3-NaNO_3$ systems. In the first was established a compound with the composition $Li_3Pr(NO_3)_6$, melting incongruently at 282 ± 2°C and forming a eutectic with $LiNO_3$ with the eutectic composition of 10.6 mol % $Pr(NO_3)_3$. In the $Pr(NO_3)_3-NaNO_3$ system a compound of the form $Na_3Pr(NO_3)_6$ was established on the basis of a comparison of the experimental solubility curves with theoretical data calculated from the Shreder equation. (tr-auth)

3021 EFFECT OF COMPLEX FORMATION IN THE AQUEOUS PHASE ON THE DISTRIBUTION OF METALS IN EXTRACTION SYSTEMS. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. pp 75-79 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

On the basis of data on the complex formation of U(VI), Np(VI), Pu(VI), and Zr(IV) with F^- and SiF_6^{2-} ions and the distribution of these metals in a 100% TBP–HNO_3 system (in the absence of ligands), calculated values were obtained for the distribution coefficients for systems with the ligands indicated. The good agreement of the calculated data with experimental data proves the accuracy of the proposed mechanism for the interaction of SiF_6^{2-} ions with ions of metals of different valencies and also proves the validity of the calculation of the complex-formation constant. (tr-auth)

3022 COMPLEX COMPOUNDS OF RUTHENIUM FORMED DURING ITS EXTRACTION WITH PHOSPHO-ORGANIC COMPOUNDS. IV. Extraction of Chloride Complexes of Ru(IV). Sinitsyn, N. M.; Travkin, V. F. pp 80-85 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The effect of the nature and concentration of neutral phospho-organic extractants on the extraction of Ru(IV) in the form of $[RuCl_6]^{2-}$ and $[Ru_2OCl_{10}]^{4-}$ complexes was studied. The effect of the structure of the internal coordination sphere in the aqueous phase and of the hydrolysis process of the chloride complexes occurring during aging of the aqueous solutions was established. (tr-auth)

3023 KINETICS OF THE REDUCTION RE-EXTRACTION OF PLUTONIUM IN THE SYSTEM TRIBUTYL PHOSPHATE–NITRIC ACID–IRON (II) DURING MIXING OF THE LIQUIDS IN A CENTRIFUGAL FIELD. Kuznetsov, G. I.; Kasimov, F. D.; Pushlonkov, M. F.; Andreev, G. M. pp 92-97 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The kinetics of the re-extraction of Pu by solutions of nitric acid from TBP using Fe(II) as a reducing agent were studied. It was shown that under the conditions studied the kinetics of the process are determined by the rate of inter-phase transfer of the Pu and by the rate of the reducing reaction. A kinetic equation for the process was derived and the rate constants were

determined. The activation energy for the reduction of Pu(IV) by Fe(II) in 2.5M HNO_3 was equal to 18.1 kcal/mol. (tr-auth)

3024 EXTRACTION OF THIOCYANATE COMPLEXES OF THORIUM AND LANTHANUM BY TRIBUTYL PHOSPHATE. Golub, A. M.; Dabeka, R. V.; Koval, V. T. pp 97-101 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The effect of the pH, concentration of thiocyanate ions, and TBP concentration in the extraction of Th and La was studied. The composition of the extracted complex was established. The conditions under which complete separation of Th and La occur were determined. (tr-auth)

3025 EXTRACTION OF ZIRCONIUM, THORIUM, AND SCANDIUM BY AMIDES OF ALKYLPHOSPHORIC ACIDS. Alimarin, I. P.; Fadeeva, V. I.; Nifant'ev, E. I.; Litvincheva, A. A. pp 102-109 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauk Leningradskoe Otdelenie (1974). (In Russian).

The extraction of Zr, Sc, and Th by different amidophosphates from solutions of nitric, hydrochloric, and thiocyanic acids was studied. The composition of the solvates formed during the extraction process was established. Under conditions optimum for Zr extraction the extraction of Fe(II) and (III), Ga, In, Mo, W, Nb, Ta, and the rare earth elements was also studied. (tr-auth)

3026 EXTRACTION OF TRACE QUANTITIES OF Ce(III) BY DIARYLPHOSPHORIC ACIDS FROM NITRIC ACID SOLUTIONS. Fomin, V. V.; Potapova, S. A. pp 109-115 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The extraction of Ce(III) from HNO_3 solutions by diarylphosphoric acids in different solvents was studied. The composition of the extracted compound was determined and the apparent extraction constants were calculated. Comparative data on the extraction by reagents of the type $(RO)_2POOH$ were reported. (tr-auth)

3027 EXTRACTION OF RARE EARTH ELEMENTS BY TRIISOAMYLPHOSPHINE OXIDE FROM THIOCYANATE SOLUTIONS. Mikhailichenko, A. I.; Yusupova, G. K. pp 115-120 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The regularities in the extraction of microquantities of rare earths by the oxide of triisoamylphosphine were studied. The growth of the distribution coefficients of the rare earth elements with increase of the concentration of the extracting agent and the thiocyanate ions and increase of pH of the aqueous phase was shown. The mechanism of the extraction and the composition of the extracted solvates were established. The dependence of the distribution coefficients on the nature of the solvent and the atomic number of the rare earths was shown. Experimental data were given for Lu, Tm, La, Eu, Gd, Ce, and Er. (tr-auth)

3028 DIALKYLPHOSPHONIC AND DIALKYLPHOSPHINIC ACIDS AS EXTRACTANTS OF RARE EARTH ELEMENTS. Mikhailichenko, A. I.; Pimenova, R. M.; Petker, S. R. pp 120-125 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The extraction of rare earths from hydrochloric acid solutions by phosphonic and phosphinic acids was studied. The presence of two mechanisms, cation exchange and solvation, was established. The composition of the extracted compound and the values of the separation coefficients of the heavy rare earths were determined. Experimental data were reported for Ho, Er, Tm, Yb, Lu, and Y. (tr-auth)

3029 EXTRACTION OF RARE EARTHS BY TRIISOAMYLPHOSPHINE OXIDE FROM NITRATE SOLUTIONS. Mikhailichenko, A. I. pp 125-129 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The regularities in the extraction of trace amounts rare earths from nitrate solutions by triisoamylphosphine oxide were studied. The extraction mechanism was established and the composition of the extracted solvates was determined. The distribution coefficients of the rare earths during extraction from diluted solutions of nitric acid were determined. (tr-auth)

3030 EXTRACTION OF THE RARE EARTHS BY TRICAPRYLMETHYLAMMONIUM THIOCYANATE. Mikhailichenko, A. I.; Dozhdeva, N. M. pp 129-134 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The effect of different factors on the extraction of rare earths was studied. The distribution coefficients increased with increase of the extractant concentration, pH of the aqueous solution, and concentration of thiocyanate ions. The extraction mechanism and the composition of the extracted solvates were determined. The distribution coefficients of the rare earths increase with increase of the atomic number. The distribution coefficients also strongly depend on the nature of the inert solvent of the extracting agent. (tr-auth)

3031 EFFECT OF INDIUM ON THE EXTRACTION OF TRACE ELEMENTS FROM BROMIDE SOLUTIONS BY METHYL ISOBUTYL KETONE AND 2,2'-DICHLORODIETHYL ETHER. Sokolov, A. B.; Zolotov, Yu. A. pp 142-148 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The effect of the concentration of In in the organic phase on the extraction of microquantities of Zn, Tl(III), Sn(IV), Te(IV), Hg, Cd, Sb(III), Bi, Sc, and As(III) from 5M HBr was studied using radioisotopes. The extraction of In itself and of Zn, Cd, and Sb in the absence of In and in the presence of 0.5M In was determined as a function of the HBr concentration from 0.5 to 6M. It was established that the extraction of the majority of the trace elements is significantly reduced in the presence of macroquantities of In; the distribution coefficients D decrease a hundred times. The change of D of the trace elements with change of the concentration of In in the extract has the same character as the change in D of In itself. The suppression of the extraction of the trace elements was explained by the dissociation of complex metal-halogenide acid in the organic phase and the general ion effect (H^+ ion) caused by it. (tr-auth)

Inorganic, Organic, and Physical Chemistry

Chemical and Physicochemical Properties

Refer also to abstracts 3019, 3020, 3130, 3144, 3145, 3911, and 4147.

3032 (AD/A-002587) SYNTHESIS OF STERICALLY RIGID CYSTAMINE DERIVATIVES. Final Report, 1 June 1969–31 August 1971. Wilson, R. M.; Buchanan, D. N. (Cincinnati Univ., Ohio (USA)). Jul 1974. Contract DADA17-69-C-9107. 29p. NTIS $3.75.

The possibility exists that the cystamine class of radiation protection drugs may be active only in certain conformations. If this should prove to be the case then cystamine derivatives that are rigidly held in the required conformation may be much more effective radiation protection agents than the freely rotating cystamine. This investigation has been directed toward the synthesis of bicyclic disulfides that can be converted into cystamine derivatives. One approach was directed towards the syntheses of the syn and anti isomers of 8-amino-2,3-dithiabicyclo (3.2.1) octane. A single isomer of 2,3-dithiabicyclo (3.2.1) octan-8-ol was prepared. A potential precursor for the anti isomer has been obtained in the form of trans-2, trans-6-dithioacetylcyclohexr-1-yl acetate. The preparations of the p-toluenesulfonate and trifluoromethanesulfonate esters of syn-2,3-dithiabicyclo (3.2.1) octan-8-ol are described. (GRA)

3033 (JUL-1107-NC) ELECTRON SPIN RESONANCE OF TECHNETIUM(IV) AND RHENIUM(IV) IN TIN DIOXIDE SINGLE CRYSTALS. Pieper, H. H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Nuklearchemie; Technische Hochschule Aachen (F.R. Germany)). Sep 1974. 86p. (In German). INIS.

ESR spectral studies are reported on the hyperfine structure of tetravalent rhenium (^{185}Re and ^{187}Re with $I = 5/2$) and technetium (^{99}Tc with $I = 9/2$) in tin dioxide single crystals. The crystals were oriented by means of Laue photographs. From the position of the resonances as a function of the angle it can be concluded, with the symmetry of the lattice point taken into account, that both Re(IV) and Tc(IV) are incorporated into tin lattice points in tin dioxide in the method of doping by means of thermal diffusion. The orthorhombic crystal field in connection with spin-orbit coupling splits the octahedral ground state $^4A_{2g}$ into two Kramers doublets. No exact determination is possible of the crystal field parameters D and E. The best agreement between the g-values in the X- and Q-bands was obtained for SnO_2 : Re(IV) for $/D/ = 53$ GHz, $/E/ = 9.5$ GHz. For the SnO_2: Tc(IV) system, /D/ was estimated from optical data to be 74 GHz. In agreement with the smaller ion radius of Tc^{4+} as against Re^{4+} the orthorhombic

distortion is smaller than in the case of SnO_2: Re(IV), /E/ being approximately 6 GHz. The hyperfine interaction with adjacent tin nuclei observed in the two systems again indicates the presence of strong covalent bonding fractions. The SnO_2: Tc(IV) system shows a non-equidistant super-hyperfine structure for the main directions with the mean coupling constants $A_z^{Sn_a} = 50$ G and $A_{x,y}^{Sn_a} = 58$ G, which is caused by the nearest tin nuclei. Supplementary to the ESR studies optical absorption measurements were performed on single crystals of the two systems at room temperature and 4.2 K and the cubic field strength parameter Δ for SnO_2: Re(IV) was estimated to be 30,000 cm^{-1}; for SnO_2: Tc(IV), 26,000 cm^{-1}. (GE)

3034 (ORNL-TM-4854) COMPUTER SIMULATION OF THE STEAM–GRAPHITE REACTION UNDER ISOTHERMAL AND STEADY-STATE CONDITIONS. Joy, D. S.; Stem, S. C. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 55p. Dep. NTIS $5.45.

A mathematical model was formulated to describe the isothermal, steady-state diffusion and reaction of steam in a graphite matrix. A generalized Langmuir-Hinshelwood equation is used to represent the steam-graphite reaction rate. The model also includes diffusion in the gas phase adjacent to the graphite matrix. A computer program, written to numerically integrate the resulting differential equations, is described. The coupled nonlinear differential equations in the graphite phase are solved using the IBM Continuous System Modeling Program. Classical finite difference techniques are used for the gas-phase calculations. An iterative procedure is required to couple the two sets of calculations. Several sample problems are presented to demonstrate the utility of the model. (auth)

3035 (ORNL-tr-2912) STANDARD FREE ENERGY OF FORMATION MEASUREMENTS OF VARIOUS METAL FLUORIDE ELECTRODES BY SOLID BATTERY ELECTROMOTIVE FORCE METHOD. Tanaka, H.; Yamaguchi, A.; Moriyama, J. Translated by H. Kubota from J. Jap. Inst. Metals; 35: 1161-1164(1971). 10p. Dep. NTIS $4.00.

The standard free energies for formation of AlF_3, ThF_4, UF_3, UF_4, CrF_2, MnF_2 and CrF_3 were determined by emf measurements. From the emf values and DELTA/super f/ G^0 (MgF_2) obtained from DELTA/super f/ H^0 data by calorimetry measurements, the standard free energies of formation of the above fluorides at 600°C were calculated as follows: DELTA/super f/ G^0 (AlF_3) equals -306.0 +- 0.2, DELTA/super f/ G^0 (ThF_4) equals -436.6 +- 0.8, DELTA/super f/ G^0 (UF_3) equals -310.9 +- 0.8, DELTA/super f/ G^0 (UF_4) equals -394.0 +- 1.3, DELTA/super f/ G^0 (CrF_2) equals -156.4 +- 0.3, DELTA/super f/ G^0 (MnF_2) equals -175.0 +- 0.2, DELTA/super f/ G^0 (CrF_3) equals -229.1 equals 1.0. (kcal/mol). (auth)

3036 (ORNL-tr-2922) RUTHENIUM OXIDES AND TRAPPING OF VOLATILE RUTHENIUM COMPOUNDS. Courtois, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). Nov 1974. Translation by Martha Gerrard of CEA-Bib-213. 36p. Dep. NTIS $5.00.

A review is presented of the preparation, chemical and physical properties, and thermodynamic properties of RuO_2, RuO_3, and RuO_4. The trapping of volatile Ru fluorides and of RuO_4 on various materials is summarized. The purpose of the review is to give an understanding of Ru behavior in a fluoride volatility process. (79 references) (JSR)

3037 EQUILIBRIUM IN THE OXIDATION OF IODINE BY HYPERAZEOTROPIC NITRIC ACID. Mailen, J. C. (Oak Ridge National Lab., TN). J. Inorg. Nucl. Chem.; 37: No. 4, 1019-1023 (Apr 1975).

Kinetic studies have shown that the oxidation of iodine by hyperazeotropic nitric acid proceeds in at least two sequential steps. The kinetic and equilibrium data presented here suggest that these steps are oxidation of I^0 to I^+ and oxidation of I^+ to IO_3^-. The experimental results were analyzed according to the following reactions: $I_2 + 4HNO_3 \rightleftharpoons 2I^+ + 2NO_3^- + N_2O_4 + 2H_2O$, $I^+ + 3HNO_3 + NO_3^- \rightleftharpoons IO_3^- + H^+ + 2N_2O_4 + H_2O$. Equilibrium constants for these reactions are derived. (auth)

3038 REACTION OF HYDROGEN WITH LIQUID POTASSIUM. Parry, G.; Pulham, R. J. (Nottingham Univ., Eng.). J. Chem. Soc., Dalton Trans.; No. 5, 446-448(1975).

A jet of clean potassium is continuously injected into hydrogen. A miniature electromagnetic pump is used to recirculate the molten metal. Rates of reaction of the gas with the metal surface over the pressure range 22.2 to 0.3 kN m^{-2} have been measured at temperatures between 210 and 333°C. The reaction obeys first-order kinetics with an apparent activation energy of 66.5 kJ mol^{-1} which is slightly lower than that (72.4) for sodium. At the higher temperatures the process is complicated by the gradually increasing dissociation pressure of potassium hydride. (auth)

3039 NEPHELAUXETIC EFFECT IN DIVALENT RARE EARTH IONS. Casanova Alig, R. (RCA Labs., Princeton, NJ). RCA Rev.; 36: No. 1, 125-131(Mar 1975).

Recent measurements of the optical spectra of divalent rare earth impurities in alkaline earth halide hosts cannot be explained using only crystal field theory, i.e., by a description of the host as a lattice of point charges. To account for the nephelauxetic effect (the reduction of the electrostatic interaction of the impurity electrons) found in these spectra, it must be assumed that the impurity electrons and the nearby halide electrons form molecular orbitals. The work leading to these conclusions is reviewed here. (auth)

3040 ANODIZATION PRODUCTS OF TANTALUM IN THE FUSED LiCl–KCl EUTECTIC. Bailey, R. A.; Balko, E. N.; Nobile, A. A. (Rensselaer Polytechnic Inst., Troy, NY). J. Inorg. Nucl. Chem.; 37: No. 4, 971-974(Apr 1975).

Voltammetry, cyclic voltammetry, and chronopotentiometry of Ta in the LiCl–KCl eutectic melt showed that anodization of Ta metal produces Ta(V), Ta(IV), and a lower stage (probably Ta(II)). Ta(V) slowly volatilized from the melt at 450°C. The Ta(V) ⇌ Ta(IV) redox reaction is reversible with an approximate $E^0 = -0.67$V. Both Ta(IV) and Ta(II) are reduced to solid products, probably to the metal, in the vicinity of −1.7 and −2.2 volts (all potentials vs standard Pt(II) Pt/(0)). Spectra show that Ta(V) in the melt is present as $[TaCl_6]^-$. (auth)

3041 KOMPLEKSOOBRAZOVANIE I EKSTRAKTSIYA AKTINOIDOV I LANTANOIDOV. (Complex Formation and Extraction of Actinides and Lanthanides). Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). 164p.

Complex formation and extraction of actinides and lanthanides have primary importance for the solution of practical and theoretical problems of contemporary radiochemistry. Original experimental and theoretical studies on the chemistry of complex compounds of U, Np, Pu, Am, Cm, and the rare earth elements are compiled. Studies dealing with the study of extraction processes for these elements, having great significance in the concentration and separation of the actinides and lanthanides, are also included. Separate abstracts were prepared for 25 of the 29 papers. (tr-auth)

For abstracts of individual papers see: 3019–3031, and 3135–3146.

Isotope Effects

3042 NORMAL COORDINATE TREATMENT OF PYRAZOLE AND ITS ISOTOPE SUBSTITUTED DERIVATIVES. Troitskaya, V. S.; Timoshenkova, Yu. D.; Vinokurov, V. G.; Tyulin, V. I. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 6, 677-681(1974). (In Russian).

The frequency assignment of vibrational spectra of $^{15}N_2$-pyrazole, $^{14}N_2$-pyrazole, 1-d-pyrazole, 1,4-d_2-pyrazole and d_4-pyrazole was performed from the calculation of frequencies and forms of the normal vibrations of compounds mentioned and from the potential energy distribution. (auth)

3043 RATE CONSTANTS AND KINETIC DEUTERIUM ISOTOPE EFFECTS FOR HYDROGEN ATOM ABSTRACTION FROM PHENOLS BY POLYVINYL ACETATE RADICAL. Simonyi, M. (Magyar Tudomanyos Akademia, Budapest); Fitos, I.; Kardos, J.; Lukovits, I.; Pospisil, J. J. Chem. Soc., Chem. Commun.; No. 7, 252(2 Apr 1975).

The primary kinetic deuterium isotope effect (PKIE) for the hydrogen atom abstraction from substituted phenols by polyvinyl acetate radical shows a large variation, and shows a maximum as a function of the reactivity of the compounds; the high values of PKIE may be attributed to tunnelling. (auth)

3044 DEUTERIUM ISOTOPE EFFECTS IN COMPLEXATION KINETICS. III. The Association Between Magnesium(II) and Pyrophosphate. Silber, H.; Wehner, P. (Maryland Univ., Baltimore). J. Inorg. Nucl. Chem.; 37: No. 4, 1025-1030(Apr 1975).

The association reaction between Mg(II) and pyrophosphoric acid was investigated in H_2O and D_2O through the use of the temperature jump relaxation technique. Electrochemical measurements in both solvents were carried out at 22°C in 0.20 M $NaNO_3$ to determine the acid dissociation constants. In H_2O, $pK_3 = 5.76 \pm 0.04$ and $pK_4 = 8.04 \pm 0.10$ and in D_2O, $pK_3 = 6.14 \pm 0.10$ and $pK_4 = 8.44 \pm 0.26$. The kinetics of the association reaction $Mg(II) + HP_2O_7^{3-} \underset{k_d}{\overset{k_f}{\rightleftharpoons}} MgHP_2O_7^-$ were determined at 15°C and $k_f = (2.1 \pm 0.1) \times 10^6 M^{-1} sec^{-1}$ and $k_d = (3.1 \pm 0.4) \times 10^3\ sec^{-1}$. In D_2O, k_f was a factor of 2.4 times slower than in water while k_d was 25% faster. These results were interpreted in terms of the Eigen-Tamm

complexation mechanism, with the isotope effect occurring in the step involving the diffusion-controlled formation of the outer-sphere complex. (auth)

3045 ROTATION-VIBRATIONAL ANALYSIS FOR THREE STATES OF NaH AND NaD. Sachs, E.S.; Hinze, J. (Department of Chemistry, University of Chicago, Chicago, Illinois 60637); Sabelli, N.H. J. Chem. Phys. 62: No. 9, 3377-3383 (1 May 1975).

We have carried out a rotation–vibrational analysis for the $X^1\Sigma^+$, $A^1\Sigma^+$, and $b^3\Pi$ states of NaH and NaD using accurate *ab initio* calculated potential curves. The calculated values of B_e, α_e, R_e, ω_e, and $\omega_e x_e$ (with known experimental values in parentheses) are NaH $X^1\Sigma^+$: B_e = 4.748 (4.886) cm^{-1}, α_e = 0.126 (0.129) cm^{-1}, R_e = 3.625 (3.562) bohr, ω_e = 1183.17 (1172.2) cm^{-1}, and $\omega_e x_e$ = 21.23 (19.72) cm^{-1}; NaD $X^1\Sigma^+$: B_e = 2.475 (2.5575) cm^{-1}, α_e = 0.0474 (0.0520) cm^{-1}, R_e = 3.624 (3.565) bohr, ω_e = 826.60 (826.10) cm^{-1} and $\omega_e x_e$ = 9.44 cm^{-1}; NaH $b^3\Pi$: B_e = 3.533 cm^{-1}, α_e = 0.853 cm^{-1}, R_e = 4.202 bohr, ω_e = 419.39 cm^{-1} and $\omega_e x_e$ = 50.25 cm^{-1}; NaD $b^3\Pi$: B_e = 1.763 cm^{-1}, α_e = 0.265 cm^{-1}, R_e = 4.294 bohr, ω_e = 311.95 cm^{-1} and $\omega_e x_e$ = 28.68 cm^{-1}. The anomalous behavior of the B_v's and $\Delta G_{v+1/2}$'s of the $A^1\Sigma^+$ state is satisfactorily reproduced by these calculations: for NaH, B_v (max) = 1.9717 (1.941) cm^{-1} at v = 6 (6) and $\Delta G_{v+1/2}$ (max) = 381.37 (360.3) cm^{-1} at v = 9 (8); for NaD, B_v (max) = 1.0274 (1.012) cm^{-1} at v = 8 (8) and $\Delta G_{v+1/2}$ (max) = 275.34 (260.22) cm^{-1} at v = 13 (12). The wavefunctions obtained were also used to calculate average electric dipole moments resulting in the following values (for the lowest rotation–vibrational states): for NaH, μ_e ($X^1\Sigma^+$) = 2.674 a.u., μ_e ($A^1\Sigma^+$) = 0.189 a.u., and μ_e ($b^3\Pi$) = 0.158 a.u., for NaD, μ_e ($X^1\Sigma^+$) = 2.668 a.u., μ_e ($A^1\Sigma^+$) = 0.178 a.u., and μ_e ($b^3\Pi$) = 0.163 a.u. (auth)

3046 AN INVESTIGATION OF NONEQUILIBRIUM KINETIC ISOTOPE EFFECTS IN CHEMICALLY ACTIVATED ETHYL RADICALS. Cowfer, J.A.; Michael, J.V. (Carnegie-Mellon University, Department of Chemistry, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 62: No. 9, 3504-3516 (1 May 1975).

The reactions of thermal H and D atoms with C_2H_4 and C_2D_4 have been studied in helium diluent at room temperature with a discharge flow system time of flight mass spectrometric apparatus. New absolute measurements of the apparent bimolecular rate constants, under atom excess conditions, for the reactions $D+C_2H_4$, $H+C_2D_4$, and $D+C_2D_4$ have been obtained as a function of pressure. Mechanistic studies have also been carried out for the $D+C_2H_4$ and $H+C_2D_4$ reactions in the pressure region of 1–5 torr. The observed pressure dependence of the rate constants and the mechanisms for the two mixed cases have been found to differ markedly. The variation in over-all mechanism for the mixed isotope cases, ethyl-d_1 and ethyl-d_4, and the nonequilibrium kinetic isotope effects for chemically activated ethyl radicals are presented and compared with other work. RRKM theoretical calculations are shown to be consistent with the experimental observations for the four systems. (auth)

3047 A NEUTRON DIFFRACTION STUDY OF THE DIAQUOHYDRONIUM ION IN YTTRIUM OXALATE TRIHYDRATE. Brunton, G.D.; Johnson, C.K. (Chemical Technology Division and Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Chem. Phys. 62: No. 9, 3797-3806 (1 May 1975).

Five structures of yttrium oxalate trihydrate and its deuterated isomorphs have been determined from least-squares refinement of neutron diffraction data. Three structures with different H–D isotopic ratios were determined from 25 °C data and two structures with the same isotopic ratios were determined from data collected at 60 and −155 °C. The cell dimensions for the structures are as follows: YHOX 25 °C, a_0 = 8.6962(6) Å, c_0 = 12.824(3) Å YDOX 25 °C, a_0 = 8.6989(7) Å, c_0 = 12.818(3) Å YHDOX 25 °C, a_0 = 8.704(2) Å, c_0 = 12.832(2) Å YHDOX 60 °C, a_0 = 8.708(2) Å, c_0 = 6.435(3) Å YHDOX −155 °C, a_0 = 8.677(4) Å, c_0 = 12.751(7) Å. In each of the structures a proton or deuteron is on a twofold symmetry axis and nearly centered between two H_2O molecules forming an H_5O_2 ion. The O–H–O bond is symmetrical but not linear; the z parameters for H and O are slightly different. The O–H–O distance in the diaquo ion is 2.442(2) Å, and the O–D–O distance is 2.454(2) Å. The four other protons in the diaquo ion (paired by symmetry) form nonlinear hydrogen bonds with O atoms in the oxalate molecules [2.643(2) and 2.680(2) Å]. The respective O–H–O angles are 178.2(3)° and 167.9(3)°. There is a nonequilibrium temperature dependence of the partitioning of hydrogen and deuterium among the available proton positions. The centered proton in the H_5O_2 is the preferred site for hydrogen and the H/D ratio increases with decreasing temperature. Between −155 and 25 °C the structure of $YH(C_2O_4)_2 \cdot 3H_2O$ becomes progressively disordered with respect to the $H_5O_2^+$ ion. At approximately 53 °C, there is a dimorphic transition in the structure and both the independent water molecule and the diaquo ion become disordered and the space group changes from $P4_2/n$ to $P4/n$; c_0 is halved. The progressive disorder is superimposed upon the $P4/n$ disorder. (auth)

3048 KINETIC ISOTOPE EFFECTS IN SOME REACTIONS OF TRI-(4-NITROPHENYL)-METHANE WITH ALKOXIDE BASES IN VARIOUS ALCOHOLIC MEDIA. Caldin, E. F.; Dawson, E.; Hyde, R. M.; Queen, A. (Kent Univ., Canterbury, Eng.). J. Chem. Soc.; Faraday Trans., I; 71: No. 3, 528-538(1975).

Rate constants and Arrhenius parameters have been determined for proton-transfer and deuteron-transfer reactions of tri-(4-nitrophenyl)-methane with alkoxide ions in alcohol + toluene mixtures. The kinetic isotope effects (k^H/k^D) at 25°C are considerable (8.4 in ethanol + toluene, 8.9 in propan-2-ol + toluene, 23 in t-butanol + toluene) and indicate that the rate-limiting step is a proton transfer. For the forward reactions, the results suggest that the importance of tunnelling increases with the size of the alkoxide group. For the backward reactions, the rates for proton- and deuteron-transfer are different, although they would be expected to be equal by reason of rapid exchange with the solvent; this suggests that in the product the proton remains firmly bonded to the carbanion. (auth)

3049 ISOTOPE FREQUENCY SHIFT OF MATRIX INSULATED CCl_4 WITH ^{35}Cl- and ^{37}Cl-ENRICHMENT AND THEIR EVALUATION FOR CALCULATION FORCE CONSTANTS. Becher, H. J.;Schnoeckel, H.; Willner, H. (Muenster Univ. (F. R. Germany). Anorganisch-Chemisches Inst.). Z. Phys. Chem. (Frankfurt); 92: No. 1-3, 33-44(Sep 1974). (In German).

CCl_4 was prepared with >98% ^{35}Cl and also with >90% ^{37}Cl enrichment. The site splitting and the isotopic shift of the fundamental ν_3 and the combination $\nu_1 + \nu_4$ in its infrared spectra was examined, the CCl_4 being isolated in matrices of Ar, $SiCl_4$, $GeCl_4$ or $SnCl_4$. The $^{35}Cl/^{37}Cl$ shift of the fundamentals ν_1, ν_2 and ν_4 in the Raman spectrum was also measured. Several ways are shown to estimate the Fermi influence on the isotopic shifts of ν_3 and $\nu_1 + \nu_4$. The corrected isotopic shifts allow consistent force constant calculations. (auth)

3050 METHYL-d_3 ISOTOPE EFFECTS, ALPHA-METHYL HYDROGEN RATE EFFECTS, AND THE ANALYSIS OF SOME SOLVOLYTIC REACTION MECHANISMS. Fisher, R. D. (Indiana Univ., Bloomington); Seib, R. C.; Shiner, V. J. Jr.; Szele, I.; Tomic, M.; Sunko, D. E. (c). J. Amer. Chem. Soc.; 97: No. 9, 2408-2413(30 Apr 1975).

The previously published linear correlation between the logarithms of the rate effect of alpha-methyl substitution for alpha-H in carbonium ion reactions and the logarithms of the rate effect of alpha-methyl deuteration has been shown to apply to several new examples. Deviations from the correlation in the direction of larger alpha-CH_3/CD_3 effects for some solvolyses of 2-methyl-2-chloroadamantane have been shown to be caused by a contribution to the isotope effects from partial rate-determining elimination in the tight ion pair. The deviation already observed for 7-methyl-norbornyl tosylate seems to have a similar cause, but the mechanistic picture is further complicated by the occurrence of elimination at both intimate and solvent-separated ion pair stages. (auth)

3051 MEAN SQUARE FORCE IN SIMPLE LIQUIDS AND SOLIDS FROM ISOTOPE EFFECT STUDIES. Bigeleisen, J.; Lee, M. W.; Mandel, F. (Univ. of Rochester, NY). Acc. Chem. Res.; 8: No. 5, 179-184(May 1975).

Experimental and theoretical studies on the isotopic separation factor and vapor pressure ratio in Ne, Ar, and Kr are critically reviewed. The information that can be obtained from these studies on the mean square force between liquid and solid states, translational motion in a condensed phase, the law of corresponding states, and radial distribution functions is analyzed. (JSR)

3052 VIBRATIONAL SPECTRUM AND FORCE FIELD OF MOLYBDENUM HEXAFLUORIDE. McDowell, R.S.; Sherman, R.J.; Asprey, L.B.; Kennedy, R.C. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). J. Chem. Phys. 62: No. 10, 3974-3978 (15 May 1975).

Infrared and Raman spectra are reported for $^{92}MoF_6$ and $^{100}MoF_6$ vapor (isotopic purities > 97%). The infrared-active stretching fundamental ν_3 exhibits partially resolved PQR structure with an asymmetric Q branch, from which the band origin ν_0 can be estimated; the isotopic frequency shift for the band origin is $\Delta\nu_3 = 8.1 \pm 0.3$ cm^{-1}. The shift of the Q branch maximum of the other F_{1u} fundamental is $\Delta\nu_4 = 3.0 \pm 0.4$ cm^{-1}. With the aid of these two isotope shifts, the general quadratic symmetry and valence force constants of MoF_6 are calculated. The primary valence force constants are $f_r = 4.94$ and $f_\alpha \simeq 0.22$ mdyn/Å. The force fields of MoF_6, WF_6, and UF_6 are compared and discussed. (auth)

3053 TEMPERATURE DEPENDENCE OF THERMAL DIFFUSION IN CO ISOTOPIC GAS MIXTURES. Verlin, J.D.; Matzen, M.K.; Hoffman, D.K. (Ames Laboratory-USAEC and Department of Chemistry, Iowa State University, Ames, Iowa 50010). J. Chem. Phys. 62: No. 10, 4151-4155 (15 May 1975).

The temperature dependence of thermal diffusion in several different isotopic gas mixtures of CO is investigated theoretically and the results are compared with experiment. The temperature range includes the inversion temperatures for all mixtures. Thermal conductivity and diffusion coefficients are also calculated. The basis of the study is a previously presented theory which provides expressions for classical collision integrals for molecules with rotational structure in terms of spherical Ω^* integrals. (auth)

3054 ELECTRON TRANSPORT AND ION CLUSTERING REACTIONS IN WATER VAPOR AND DEUTERATED WATER VAPOR. Wilson, J.F.; Davis, F.J.; Nelson, D.R.; Compton, R.N. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Crawford, O.H. J. Chem. Phys. 62: No. 10, 4204-4212 (15 May 1975).

The interaction of low energy electrons and negative ions with pure water vapor and deuterated water vapor has been studied in the following two experiments: (I) A time-of-flight electron swarm experiment has been used to determine longitudinal electron diffusion coefficients, D_L, in H_2O and D_2O for electric-field-to-pressure ratios, E/P, from 1 to 25 V cm^{-1}·Torr^{-1}. The ratio of the longitudinal diffusion coefficient to mobility D_T/μ for D_2O is greater than that for H_2O in the range of E/P from 5 to 20 V cm^{-1}·Torr^{-1}. Measurements of D_T/μ for H_2O are in agreement with the calculations of Lowke and Parker. Electron drift velocities have also been measured for values of E/P from 0.5 to 25 V cm^{-1}·Torr^{-1}, and the values for D_2O are found to be considerably greater than for H_2O in the range of E/P from 10 to 25 V cm^{-1}·Torr^{-1}. This result is justified on the basis of the energy dependence of the momentum transfer cross section for polar molecules. (II) Negative ions with masses in the range from 1 to 200 amu produced by electron swarm interactions and subsequent ion–molecule and ion–clustering reactions in H_2O and D_2O at room temperature have been recorded as a function of E/P from 0 to 70 V cm^{-1}·Torr^{-1} and pressures from 0.1 to 5 Torr. The ions observed are $H^-(D^-)$, $OH^-(OD^-)$, and $OH^-\cdot nH_2O(OD^-\cdot nD_2O)$ where $n=1$ to 7. The appearance of cluster ions from D_2O occurred at a lower E/P than from H_2O. This observation is compatible with our reported measurements of the characteristic electron energies (D/μ) for these vapors. The variation of the cluster ion distribution with pressure and E/P verifies the sequential clustering scheme suggested previously by Moruzzi and Phelps. For comparison purposes, negative ion products from electron swarm interactions with ammonia vapor are also presented. The ions observed are the primary ions H^- and NH_2^- and the cluster ions $NH_2^-\cdot nNH_3$ where n = 1 to 4. These results are at variance with the two previous studies of ammonia. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 3063 and 4424.

3055 QUASICLASSICAL TRAJECTORY STUDY OF THE MOLECULAR BEAM KINETICS OF THE DEUTERIUM ATOM–HYDROGEN HALIDE EXCHANGE REACTIONS. Raff, L.M.; Suzukawa, H.H. Jr.; Thompson, D.L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). J. Chem. Phys. 62: No. 9, 3743-3746 (1 May 1975).

Unadjusted quasiclassical trajectory computations have been carried out to simulate the molecular beam scattering of thermal D atom beams at 2800 °K crossed with beams of HCl and HI at 250 °K. Total reaction cross sections, energy partitioning distributions, and differential scattering cross sections have been computed for the exchange reactions D + HCl → DCl + H and D + HI → DI + H while total reaction cross sections are reported for the corresponding abstractions, i.e., D + HCl → HD + Cl and D + HI → HD + I. For the exchange reactions, the computed reaction cross sections are within the range estimated from the crossed beam experiments. The calculated average energy partitioned into relative translational motion of products is in near quantitative agreement with the beam results, and the predicted differential scattering cross sections appear to be in qualitative accord with the beam experiments. The over-all agreement between theory and experiment indicates that previously computed values for the thermal rate coefficients for the exchange reactions are of the right order and that a systematic error exists in the interpretation of photolysis data in the hydrogen–hydrogen halide systems. (auth)

3056 EXCHANGE PROCESSES BETWEEN ASTATINE ADSORBED ON PLATINUM AND THE AQUEOUS SOLUTION OF IODIDE IONS, IODINE, AND TRIIODIDE IONS. Nagy, G. A.; Halkin, V. A. Magy. Kem. Foly.; No. 1, 33-35(Jan 1975). (In Hungarian).

The isotopic exchange reactions between astatine, carrier-free iodine adsorbed on platinum and aqueous solutions of iodide and triiodide, respectively, proceed according to the empirical equation: $\ln (1 - F) = \ln B + A \ln t$. The constant rates of isotopic exchange for both iodine and astatine submonolayers on platinum decreased in the order $I_3^- > I_2 > I^-$. The behavior of astatine in these isotopic exchange processes and its adsorption on platinum were shown to be similar to the behavior of the carrier-free iodine. (auth)

3057 QUATERNARY METHYLSULFONYLAMMONIUM SALTS. New Reagents for Mesylation. The Mechanism of Hydrogen Multiexchange in Sulfene Reactions. King, J. F.; du Manoir, J. R. (Univ. of Western Ontario, London). J. Amer. Chem. Soc.; 97: No. 9, 2566-2567(30 Apr 1975).

A previously suggested mechanism for the formation of quaternary methylsulfonylammonium salts from the reaction of tertiary amines with methanesulfonyl chloride was confirmed and specific examples of quaternary fluorosulfonates were synthesized. The presence of excess D_2O during reactions of the quaternary salts gave D-multisubstituted methane sulfonate anions. These salts react with amines and alcohols to give the corresponding methanesulfonamides or mesylate esters and therefore appear to be reagents of choice for many mesylations. (JSR)

3058 LASER SEPARATION OF CHLORINE ISOTOPES. The Photochemical Reaction of Electronically Excited Iodine Monochloride With Halogenated Olefins. Liu, D. D. S.; Datta, S.; Zare, R. N. (Columbia Univ., New York). J. Amer. Chem. Soc.; 97: No. 9, 2557-2558(30 Apr. 1975).

The photochemical separation of ^{35}Cl and ^{37}Cl is reported when a mixture of ICl and the scavengers trans-dichloroethylene or 1,2-dibromoethylene (cis, trans mixture) is irradiated by a CW tunable dye laser that selectively excites $I^{37}Cl$. A small but significant enrichment of ^{37}Cl occurs in the exposed starting material. The use of 1,2-dibromoethylene gave higher isotopic separations. (JSR)

3059 THE CALCULATION OF ISOTOPIC PARTITION FUNCTION RATIOS BY A PERTURBATION THEORY TECHNIQUE. Singh, G.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92664). J. Chem. Phys. 62: No. 10, 4165-4180 (15 May 1975).

The vibrational Hamiltonian of a molecule in the harmonic approximation, $H = (1/2)\ \Sigma\ (g_{ij}p_ip_j + f_{ij}q_iq_j)$, has been divided into a diagonal part (terms with $i=j$) and an off-diagonal part ($i+j$), which is regarded as the perturbation. The vibrational partition function of the molecule is then calculated by Schwinger perturbation theory as the partition function of the unperturbed problem, corresponding to a collection of oscillators with frequencies $2\pi\nu_i' = (f_{ii}g_{ii})^{1/2}$, plus perturbation correction terms which are calculated to second order. With the usual assumptions of isotope effect calculations that the molecular translations and rotations are classical and separable from the vibrations, the perturbation formulation of the vibrational partition function is easily transformed into a perturbation theory formulation of (reduced) isotopic partition function ratios. If, for example, the molecular potential function is expressed in terms of the displacements of bond stretches and bond angle bends from their respective equilibrium values, the unperturbed partition function ratio corresponds to the isotope effect expected for noninteracting bond-stretch and bond-angle-bend oscillators. Detailed comparison is made for a number of molecular systems of perturbation theory calculations of partition functions and isotopic partition function ratios with exact calculations carried out by actually obtaining the normal mode vibrational frequencies of the vibrational Hamiltonian. Good agreement is found. The utility of the perturbation theory formulation resides in the fact that it permits one to look at isotope effects in a very simple manner; some demonstrations are given. (auth)

Feed Materials Processing

Refer also to abstract 3705.

3060 (AED-CONF-74-600-003) URANIUM MILLING. Kegel, K. E. (Uranerzbergbau G.m.b.H. und Co. K. G., Bonn (F. R. Germany)). 1974. 27p. (In German). INIS.

From symposium on natural uranium supply; Mainz, F. R. Germany (18 Nov 1974).

The process steps between uranium mining and further processing, i.e., the production of uranium ore concentrate (yellow cake) from uranium ore, are discussed. The different process steps are outlined: preliminary concentration, crushing, leaching (acid or alkaline), purification and concentration, precipitation. Moreover, the possibilities of developing new techniques are indicated. (GE)

3061 RECOVERY OF URANIUM FROM URANOTHORIANITE AT THE PALABORA MINING COMPANY LIMITED. Tunley, T. H. (National Inst. for Metallurgy, Johannesburg); Nel, V. W. pp 1519-1533 of Solvent Extraction. London; Society of Chemical Industry (1974).

From international solvent extraction conference; Lyon, France (8 Sep 1974).

Uranthorianite is present in the Palabora Igneous Complex and the orebody is exploited as a low-grade copper deposit. The

National Institute for Metallurgy, in association with the South African Atomic Energy Board, undertook research on behalf of the Palabora Mining Company into the most suitable methods of chemical extraction applicable to the uranothorianite concentrate produced in a pilot plant at the Palabora Mining Company. A full-scale plant produced uranium oxide for the first time in August 1971. This paper describes the operation of the plant, which produces an extremely pure grade of uranium from a very low-grade deposit. After a preliminary treatment, solvent extraction with TBP is used. (auth)

3062 BRITISH STRONG-ACID LEACH PROCESS TARGETED AT REFRACTORY URANIUM ORES. Eng. Min. J.; 176: No. 5, 105(May 1975).

The UKAEA-patented strong-acid leach process for refractory U ores is briefly outlined with emphasis on its variations from the conventional dilute-acid process and the projected economics for a processing plant using this process. The process uses 6N H_2SO_4 with a sharply reduced leaching time over conventional processes. The solubilized U is removed by percolation and the use of only about 10 percent liquid produces less effluent. Conventional processing plant equipment can be used except at the feed preparation, acid mixing, curing, and washing stages. Ore can be processed at larger grain sizes and the milling is done in a dry rod mill. Alternatives to the percolation removal of U are listed. Other work being done by UKAEA on U recovery from ores is briefly indicated. (JSR)

Radiation Chemistry

Refer also to abstracts 3054, 3648, 3652, 3654, 3655, 3664, and 4158.

3063 (AEC-tr-7533/1) NUKLEONIKA. Translation of Nukleonika; 19: No. 1, 1-78(1974). 70p. (TT-74-54003/1). Dep. NTIS $6.50.

3064 (AED-CONF-74-465-021) CROSS-LINKING OF POLYETHYLENE BY ENERGETIC RADIATION AND THE EFFECT OF COAGENTS INTENSIFYING THE PROCESS. Kammel, G.; Wiedenmann, R. (Bochum Univ. (F. R. Germany)). 1974. 9p. (In German). INIS.

From symposium on the radiation chemistry of polymers; Garching/Muenchen, F. R. Germany (23 Oct 1974).

The cross linking of polyethylene, initiated by energetic radiation, is looked on as a dose-dependent molecular weight enlargement. Thus the degree of crosslinking depends on the average molecular weight, the molecular weight distribution, as well as on the density and the degree of branching, besides the radiation dose applied. So-called short-time irradiations with accelerated electrons were examined, i.e., irradiations with high dose rates carried out in air at room temperature. (GE)

3065 (AED-CONF-74-465-023) THE SYNTHESIS OF VINYL ACETATE-ALKYL MALEATE AND FUMARATE COPOLYMERS THROUGH RADIATION. Du Plessis, I. A.; Schnautz, N. G. (Atomic Energy Board, Pelindaba, Pretoria (South Africa). Chemistry Div.). 1974. 19p. INIS.

From symposium on the radiation chemistry of polymers; Garching/Muenchen, F. R. Germany (23 Oct 1974).

The radioinduced copolymerization of vinyl acetate with diethyl maleate and with diethyl fumarate was investigated in the temperature range from −40 to 90°C over a wide range of comonomer compositions. In the case of both unsaturated esters, copolymers with vinyl acetate were obtained in which the comonomers alternate with regularity along the polymer chain over the entire range of comonomer compositions and temperature range investigated. Both the rates of copolymerization and the molecular weights of the resulting copolymers were found to depend strongly on the initial comonomer compositions. For both copolymer systems the monomer reactivity ratios were found to be practically zero. The apparent activation energy was found to change at 13°C with an increase in temperature from a value of 1.76 kcal/mole to a value of 4.31 kcal/mole in the copolymerization with diethyl maleate. In the case of the copolymerization with diethyl fumarate, the apparent activation energy changed at 21°C from a value of 1.76 kcal/mole to a value of 5.98 kcal/mole. Scavenger studies indicate that a free radical mechanism prevails over the entire temperature range investigated in the case of both copolymerizations. (auth)

3066 (A.R.E.A.E.E.-194) STUDIES ON THE RADIOLYSIS OF THE BINARY SYSTEMS (Sb III-Tl I) AND (Sb III-Cu II) IN AERATED SULFURIC ACID SOLUTIONS. Souka, N.; Abdel-Rehim, F. (Atomic Energy Establishment, Cairo (Egypt)). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

The radioinduced oxidation of trivalent antimony in the presence of Tl(I) and Cu(II) was investigated. Thallous sulfate and cupric sulfate were added to the standard antimony solution in concentration ratios ranging from 1 : 1 to 1000 : 1. After necessary corrections antimony oxidation yield was determined. The data indicated that Tl(I) does not affect G(−Sb III), while Cu(II) increases G(−Sb III). These findings were explained in terms of specific bimolecular rate constants and possible oxidation mechanisms. (auth)

3067 (COO-2367-04) ESR STUDY OF RADIATION DAMAGE IN PYRIMIDINES. Technical Progress Report, August 1, 1974-July 31, 1975. Benson, B. W. (Lehigh Univ., Bethlehem, Pa. (USA). Dept. of Physics). 1975. Contract AT(11-1)-2367. 23p. Dep. NTIS $4.25.

The primary objective of this project is to investigate radiation damage to biomolecules using substituted pyrimidines as a model system. Results this year include a general mechanism for iminoxy radical formation in nitropyrimidines, identification of free radical structures in 5-ethyl-5-isopropylbarbituric acid, 5-ethyl-5-isoamylbarbituric acid, and 5-allyl-5-isopropylbarbituric acid, demonstration that the uracilyl radical is formed by hydrogen addition to C(5) of the pyrimidine ring, construction of a k-band microwave cavity for 77°K single crystal studies, determination of several dose-response curves, and synthesis of new pyrimidine derivatives for study in the coming year. (auth)

3068 (INIS-mf-1630, pp 5-49) EFFECT OF IONIZING RADIATION ON DRUGS AND CERTAIN MEDICAL MATERIAL. Koubalik, B. 1973. (In Czech).

Described are the radiolysis of pure drugs (without solvents) in the absence of oxygen, the radiolysis of pure drugs in the presence of oxygen (radio-oxidation) and the radiolysis of water and of aqueous solutions of drugs. Ionizing radiation was found to induce nuclear and chemical alterations in drugs and in medical material, thus deteriorating them (e.g., the reduction of the pharmacological effectiveness, physical changes, etc.). (INIS)

3069 (TID/SNA-1706) PARA-ORTHOHYDROGEN CONVERSION STUDIES. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 Mar 1972. 76p. Dep. NTIS $7.00.

The data package consists of a status report entitled "Para-orthohydrogen Conversion in a Radiation Field," raw data work sheets covering all work done on Godiva-type reactors, and the design package for the Peure II side-by-side experiment. Static irradiations of parahydrogen were done in the Godiva, SPR II, ACPR, and Jezebel Reactors and the Sandia Gamma Irradiation Facility. (LK)

3070 PHOTOCHEMICAL CONVERSION OF RADICALS IN γ-IRRADIATED VINYL ACETATE AT 77°K. Fuki, V. K.; Glazman, E. B.; Mel'nikov, M. Ya.; Fok, N. V. Vestn. Mosk. Univ., Ser. II. Khim.; 15: No. 6, 706-710(1974). (In Russian).

The photolysis of anion-radical $CH_2 = CHO\dot{C}-O^-(CH_3)$ in γ-irradiated vinyl acetate (VA) and in solutions of VA in 3-methylpentane at 77°K was shown to result in the radical $CH_3\dot{C}O$. The radicals $CH_2 = \dot{C}OCOCH_3$ and radicals of the growing chain $\sim CH_2\dot{C}HOCOCH_3$ were found to decompose under the action of light (λ = 365 nm) giving the $CH_3\dot{C}O$ radicals and the molecule $CH_2 = C = O$ and $\sim CH_2 - CHO$, respectively. (auth)

3071 RADIATION POLYMERIZATION OF TETRAFLUOROETHYLENE ADSORBED ON HIGHLY POROUS SORBENTS. Bruk, M. A.; Abkin, A. D.; Lemidovich, V. V.; Eroshina, L. V.; Urman, Ya. G.; Slonim, I. Ya.; Ledeneva, N. V. (Scientific Research Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. A; 17: No. 1, 3-12(Jan 1975). (In Russian).

Using physical chemistry methods (adsorption isotherms, NMR and IR spectra), the properties of tetrafluoroethylene (TFE) adsorbed on various porous sorbents and special features of polymerization processes taking place in the adsorbed layer were studied. It was shown that the strength of the TFE bond with the surface of the sorbents studied increased in the order silica gel, brand IREA-zeolite, NaY-zeolite, CaY. The IR spectra of TFE were obtained in different aggregate states including the adsorbed (on silica gel) state. A correlation was found between the strength of the bond of the adsorbed monomer molecules with the surface and the temperature range of effective polymerization in the adsorbed layer. The sorbents had a sensitizing effect on the post-polymerization of TFE. It was shown that the rate of radiation polymerization of TFE on silica gel is determined by the monomer concentration in the adsorbed layer and not in the gas phase where the rate, depending on the monomer concentration, is unusually high. The observed pattern is explained. (tr-auth)

3072 RADIOINDUCED CROSSLINKING AND DEGRADATION OF FLUORO RUBBERS IN THE PRESENCE OF OLIGOESTER ACRYLATES. Makhlis, F. A.; Nikitin, L. Ya.; Kuz'minskii, A. S. (Scientific Research Inst. of the Resin Industry, Zagorsk, USSR). Vysokomol. Soedin., Ser. A; 17: No. 1, 170-175(Jan 1975). (In Russian).

It was shown that the rate of radioinduced cross-linking of fluoro rubbers sharply increases in the presence of oligoester acrylates (OEA), which is accompanied by three-dimensional graft polymerization of OEA in a rubber matrix. The dimensions of the hardened OEA aggregates and the kinetics of the three-dimensional graft polymerization are determined by the prepolymerization distribution of OEA in the rubber matrix. A high polarity of the fluoro rubbers is ensured by the small heterogenicity of the prepolymerization dispersion of the OEA caused by the high rate of radiation cross-linking of the elastomer and the effective strengthening of it in the absence of fillers. In the process of radiation destruction there is first a rupture of the chemical bonds in the OEA units or on their surfaces, and with further irradiation the contribution of the rubber molecules to the destruction increases. (tr-auth)

3073 EPR SPECTRA, STRUCTURE, AND CONFORMATION OF FREE RADICALS IN POLYPROPYLENE AND POLYBUTENE-1. Radtsig, V. A. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. A; 17: No. 1, 154-162(Jan 1975). (In Russian).

The structure of free radicals formed in radiolysis and mechanical destruction of polypropylene and polybutene-1 were determined from the results of EPR spectral analyses. It was shown that radicals with free valence in the middle of the chain, found in amorphous and crystalline areas of these polymers, have different conformations and correspondingly different EPR spectra. (tr-auth)

3074 BIOCHEMICAL AND BIOPHYSICAL STUDIES ON CYTOCHROME C OXIDASE. XIV. The Reaction With Cytochrome c as Studied by Pulse Radiolysis. Van Buuren, K. J. H. (Univ. of Amsterdam); Van Gelder, B. F.; Wilting, J.; Braams, R. Biochim. Biophys. Acta; 333: 421-429(26 Mar 1974).

The reduction of cytochrome c oxidase by hydrated electrons was studied in the absence and presence of cytochrome c. Hydrated electrons do not readily reduce the heme of cytochrome c oxidase. This observation supports previous conclusions that heme a is not directly exposed to the solvent. In a mixture of cytochrome c and cytochrome c oxidase, cytochrome c is first reduced by hydrated electrons ($k = 4 \cdot 10^{10}\ M^{-1} \cdot s^{-1}$ at 22°C and pH 7.2) after which it transfers electrons to cytochrome c oxidase with a rate constant of $6 \cdot 10^{7}\ M^{-1} \cdot s^{-1}$ at 22°C and pH 7.2. Two equivalents of cytochrome c are oxidized initially per equivalent of heme a reduced, showing that one electron is accepted by a second electron acceptor, probably one of the copper atoms of cytochrome c oxidase. After the initial reduction, redistribution of electrons takes place until an equilibrium is reached similar to that found in redox experiments of Tiesjema, R. H., Muijsers, A. O., and Van Gelder, B. F. (1973) Biochim. Biophys. Acta 305, 19–28. (auth)

3075 CHANGE OF THE EFFICIENCY OF THE CHROMATOGRAPHIC SYSTEM IN TRANSITION TO HIGHER ACTIVITIES. I. Comparison of Alpha and Gamma Radiolysis of a Cation Exchanger with Respect to Its Change in Weight, Salt Separation Capacity, and Residual Capacity and Its Swelling Power. Dornow, V.; Specht, S.; Weinlander, W.; Born, H. J. (Technische Univ., Munich). J. Radioanal. Chem.; 24: No. 2, 393-409(1975). (In German).

The effect of the alpha and gamma radiation were studied on the characteristics of the cation exchanger resin AG50WX8. (auth)

3076 GAMMA IRRADIATION OF CYCLITOLS. II. Irradiation of Aqueous Solution of Myo-inosite the Presence of Oxygen. Bancher, E.; Washuettl, J.; Schmidt, B.; Riederer, P.; Wurst, F. (Technische Hochschule, Vienna). J. Radioanal. Chem.; 24: No. 2, 303-312(1975). (In German).

After irradiation of an aqueous 1% myo-inosite solution in the presence of oxygen, the following radiolysis products are qualitatively demonstrable: 2,3,5/4,6-pentahydroxycyclohexanone, d,1-3,5/4,6-tetrahydroxycyclohexandione, d,1-xylo-4,5,6-trihydroxycyclohexane-1,2,3-trione, tetrahydroxy-p-benzochinon, glyoxylic acid, formic acid, and carbon dioxide. The increase in the concentration of the radiolysis products is followed by a loss of myo-inosite. These radiolysis products were quantitatively determined in relation to radiation dose. (auth)

3077 GAMMA RADIOLYSIS OF BRANCHED CHAIN HYDROCARBONS: 2,2,4-TRIMETHYLPENTANE AND 2,2,5-TRIMETHYLHEXANE. Castello, G.; Grandi, F.; Munari, S. (Univ., Genoa). Radiat. Res.; 62: No. 2, 323-336(May 1975).

The gamma radiolysis of liquid 2,2,4-trimethylpentane and 2,2,5-trimethylhexane at room temperature was investigated under vacuum at different doses. The effect of some additives and impurities (iodine, diphenolpicrylhydrazyl, oxygen and water) was also investigated. The fragmentation products, some of the recombination products, and the alkyl iodides formed by reaction of the primary radicals with the scavenger iodine were identified and measured. The yield (G) of formation of the products and the yield (G) of rupture of the different bonds of the molecules were calculated and correlated with the molecular structure. (auth)

3078 REACTION OF THE HYDRATED ELECTRON WITH AMINO ACIDS, PEPTIDES, AND PROTEINS IN AQUEOUS SOLUTION. I. Factors Affecting the Rate Constants. Tal, Y.; Faraggi, M. (Atomic Energy Commission, Beer Sheva, Israel). Radiat. Res., 62: No. 2, 337-346(May 1975).

Rate constants for the reaction of the hydrated electron with amino acids, peptides, and proteins were measured. It was confirmed that in proteins, peptides, and esters or amides of amino acid (not containing active side chains) the first site of attack is the carbonyl group. A linear free-energy relationship between the rate constant and the net charge on the carbonyl group, as calculated by the Del-Re method, is proposed. The dependence of rate constants on the number of carbonyls and on the over-all charge on the molecule was found. It was shown that the effect of this charge decreases with the increase in size of the molecule. The average rate constant of hydrated electron with a single peptide group (in uncharged molecules) was found to be $1\text{-}3 \times 10^{8}\ M^{-1}\ sec^{-1}$. It suggests that the polypeptide chain has a significant contribution to the reactivity of proteins toward the hydrated electron. (auth)

3079 REACTION OF THE HYDRATED ELECTRON WITH AMINO ACIDS, PEPTIDES, AND PROTEINS IN AQUEOUS SOLUTION. II. Formation of Radicals and Electron Transfer Reactions. Faraggi, M.; Tal, Y. (Atomic Energy Commission, Beer Sheva, Israel). Radiat. Res.; 62: No. 2, 347-356(May 1975).

The steps in the reaction of the hydrated electron with several simple peptides have been studied. As already suggested the initial step is an attachment of the e⁻/sub aq/ to a carbonyl group in the peptide chain. This reaction can be followed by a further intermolecular electron migration (depending on the nature of the peptide), resulting in a deaminated radical. Thus the reaction of e⁻/sub aq/ with peptides yields two types of radicals: the carbonyl electron adduct and the deaminated radical. These two radicals were found to differ much in their spectral and chemical properties. The absorption spectra of radicals produced from peptides of alanine and glycine were recorded and examined with respect to their pH, ionic strength and peptide concentration dependence. In agreement with previous results, at all concentrations, (greater than 90 percent) is shown to be the deamination result of the reaction of e⁻/sub aq/ with dipeptide having a protonated terminal amino group. However, different results were obtained with higher peptides (tri, tetra, etc.). Here the percentage of deamination, at low peptide concentration, decreased with increasing the number of peptide bonds [approximately 60 percent for 10^{-3} M $(gly)_3$]. This yield could be increased by increasing the peptide concentration [approximately 95 percent for 10^{-1} M $(gly)_3$]. These findings led to the suggestion that aqueous solutions of peptides at neutral pH exist at least as dimers formed by hydrogen bonds. It was further suggested that these bonds allow the migration of the electron between the carbonyl groups of the peptides this migration results in a higher yield of the deaminated radical. (auth)

3080 THE REDUCTION OF NUCLEOTIDES BY IONIZING RADIATION: URIDINE 5′ PHOSPHATE AND CYTIDINE 3′ PHOSPHATE. Box, H.C.; Potter, W.R.; Budzinski, E.E. (Department of Biophysics, Roswell Park Memorial Institute, Buffalo, New York 14203). J. Chem. Phys. 62: No. 9, 3476-3478 (1 May 1975).

Anions formed by the addition of an electron to the uracil base were observed in single crystals of the barium salt of uridine 5′ phosphate x-irradiated at 4.2 °K. The hyperfine coupling tensor for the C_6–H proton was deduced from ENDOR measurements; the principal values are −59.12, −32.92, and −16.24 MHz. Similar measurements were made on single crystals of cytidine 3′ phosphate. The principal values for the C_6–H proton hyperfine coupling in the anion formed on the cytosine base are −59.26, −33.98, and −14.68 MHz. (auth)

3081 VIBRATIONALLY EXCITED OH FROM THE REACTION OF H WITH NO_2 OBSERVED BY LASER-INDUCED FLUORESCENCE. Brophy, J.H.; Silver, J.A.; Kinsey, J.L. (Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). J. Chem. Phys. 62: No. 9, 3820-3822 (1 May 1975).

The reaction $H + NO_2 \rightarrow OH + NO$, which is widely used as a source of OH radicals for gas-kinetic studies, has been thought to yield OH almost exclusively in the ground state. However, recent experiments indicate that as much as 30% to 50% of the total energy may appear in vibrational excitation. In this study the reaction is studied using a laser-induced fluorescence method. The results indicate that as little as 10% of the total energy is in vibrational excitation. (AIP)

3082 KINETICHESKIE ISSLEDOVANIYA V IMPUL'SNOM RADIOLIZE. (Kinetic Studies in Pulse Radiolysis). Shubin,

V. N.; Frunze, T. A.; Sharanin, Yu. I. Moscow; Izdatel'stvo Nauka (1974). 216p.

The kinetic and energy characteristics of short-lived particles, arising under the effect of pulsed ionizing radiation are discussed. The possibility of using new methods of oscillating sources is examined. The methods for the mathematical processing of data of pulsed radiation chemical measurements are discussed. (tr-auth)

3083 ELECTRON SPIN RESONANCE STUDY OF RADIATION-PRODUCED RADICAL PAIRS IN SINGLE CRYSTALS OF 1-METHYLURACIL. Flossmann, W.; Mueller, A.; Westhof, E. (Univ., Regensburg, Ger.). Mol. Phys.; 29: No. 3, 703-712(Mar 1975).

Five different types of radical pairs produced in single crystals of 1-methyluracil by irradiation with x-rays were identified. Partial differentiation between pairs was achieved by utilizing different stabilities versus ultraviolet illumination or annealing, and variation of relative yields with temperature. The composition of pairs was derived from hyperfine couplings, the orientation from the maxima of dipolar couplings. These were found to agree with the directional cosines obtained from the crystal structure. Further evidence was provided by half-field spectra ($\Delta m_s = 2$). The zero-field splitting constant D was determined for five pairs, the value of E for one pair. Second-order effects observed at 9.5 GHz and at 35 GHz have been fully analyzed for two pairs by application of the appropriate theory which permitted to determine the absolute sign of D. Two pairs are homogeneously composed of hydrogen abstraction radicals 1-methyleneuracil. These are located two layers apart for one pair with the link normal to the molecular planes ($D/g\beta = -107.5$ G), and within one plane for the other (−224.0 G). The three remaining pairs consist heterogeneously of an abstraction radical and a hydrogen addition radical 1-methyl-5,6-dihydrouracil-6-yl. Two of these are intraplanar (−180.0 G; −129.0 G), and the other one located in neighboring layers (−183.0 G). (auth)

3084 STUDIES ON IRRADIATION OF AGAR–AGAR IN THE SOLID STATE: ON THE CHANGES OF MELTING POINT OF THE AGAR–AGAR HYDROGEL AND SETTING POINT OF THE AGAR–AGAR HYDROSOL PRODUCED BY IRRADIATION. Nisizawa, M. (Defence Academy, Yokosuka, Japan). Radiat. Eff.; 24: No. 3, 177-185(1975).

The effects of gamma radiation on the formation of the cross-links of the agar–agar hydrogel were studied by measuring the melting point and setting point, and by calculating the heats of reaction for the cross-linking processes at different radiation doses, times after irradiation, and concentrations of added substances (sugar and starch). Empirical equations for the melting point and the setting point were obtained. (auth)

3085 GRAFT COPOLYMERS AS ELASTOMERIC FIBERS. I. Synthesis of the Graft Copolymers. Williams, J. L.; Woods, D. K.; Stannett, V.; Sello, S. B.; Stevens, C. V. (Research Triangle Inst., Durham, NC). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 159-168(Apr 1975).

Pre-irradiation grafting, mainly with an ethyl acrylate emulsion system, has been used to produce wool and cellulosic fibers having elastomeric properties. Comparative studies using selected chemically initiated systems were also carried out. The pre-irradiation grafting-time curves were found to be auto-accelerative and grafting levels in excess of 3000% could be achieved. About 1000% graft was required to obtain fibers with high "rubber-like" elasticity. Grafting rates were found to increase substantially with temperature reducing the grafting times necessary to achieve high elasticity to the order of minutes at 35°C compared to 20 hr at ambient temperatures. Reduction of the level of grafting required to obtain elastomeric properties is clearly of interest, and it was found that when rayon fibers containing low levels of graft (below 100%) were subjected to post-treatments with reagents capable of decrystallizing cellulose, the fibers, which heretofore exhibited no significant elastomeric properties, became highly elastic. (auth)

3086 GRAFT COPOLYMERS AS ELASTOMERIC FIBERS. II. Mechanical Properties and Morphology of Grafted Copolymers. Williams, J. L.; Stannett, V.; Roldan, L. G.; Sello, S. B.; Stevens, C. V. (Research Triangle Inst., Durham, NC). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 169-178(Apr 1975).

Rayon-g-(ethylacrylate) graft copolymers, prepared via pre-irradiation grafting and also via selected chemically initiated techniques, have been characterized with respect to their mechanical properties. Electron microscopy and x-ray diffraction were used to determine the morphological and structural modifications which must be attained in order to achieve elastomeric behavior in the grafted rayon. The onset of high "rubber-like" elasticity at around 1000% graft is accompanied by a large drop in tenacity. This strength loss may be reduced without any loss in elongation by adding small quantities of bifunctional monomers to the grafting solution. Elastomeric properties were attained even at graft levels below 100% by subjecting the grafted fibers to a treatment capable of decrystallizing the cellulose. In order to achieve elastomeric properties, these studies indicate that grafting must occur evenly throughout the fiber cross-section, expanding the fiber and maintaining its crystalline regions in a disrupted state. (auth)

3087 INVESTIGATION OF GAMMA-RAY INDUCED POLYMER FORMATION IN THE CARBORANES. V. Structures of the Products and Mechanism of the Radiolysis of 1-Allyl-o-carborane. Hepburn, D. R.; Klingen, T. J. (Mississippi Univ., University). J. Inorg. Nucl. Chem.; 37: No. 4, 857-863(Apr 1975).

Investigation of the gamma-ray radiolysis of 1-allyl-1,2-dicarba-closo-dodecaborane-11, 1-allyl-o-carborane, indicated that it could be oligomerized with a $\overline{DP}_n$ of five. It can be strongly inferred from the results of this work that the reactions involved are hydrogen atom initiated processes involving abstraction to form an allylic type radical and addition to form a propyl type radical. A concurrent stage of the reaction involves coupling of the allylic type radicals to give rise to seven different unsaturated dimer products. The oligomerization reaction involving the propyl type radical as the propagating species results in the formation of a saturated oligomer in a free radical chain process which is characterized by chain transfer. Both the dimer reaction and the oligomer process are terminated by bimolecular processes. (auth)

3088 POLYMERIZATION OF VINYLIDENE CHLORIDE USING γ-RAYS AS INITIATORS. Panajkar, M. S.; Rao, K. N. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 24: No. 3, 199-205(1975).

Cobalt-60 gamma-ray-induced polymerization of vinylidine chloride has been studied, as an example of precipitating type of polymers. The percentage conversion of the monomer was not linear with the absorbed dose but showed acceleration. By studying the initial part of the curve which was linear, the initial rates of polymerization have been determined for different temperatures and dose rates. The dose rate exponent was found to be 0.48, and the energy of activation was observed to be 7.4 kcal/mol. The radical yield was determined by competition reaction with a stable free radical DPPH using the induction period method and G_R was found to be 21.0. The intrinsic viscosities of the polymers have been determined in o-dichlorobenzene at 120°C. The results show a maximum in molecular weight as the radiation dose is increased. These results as well as the results on the dose rate exponent, and energy of activation are discussed. (auth)

3089 ABSTRACTION OF CHLORINE ATOMS FROM CHLOROMETHANES BY THE CYCLOHEXYL RADICAL. Katz, M. G.; Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Centre, Yavne, Israel). Int. J. Chem. Kinet.; 7: No. 2, 183-194 (1975).

The kinetics of chlorine atom abstraction from the chloromethanes (CM) CCl_4, $CHCl_3$, and CH_2Cl_2 by radiolytically generated cyclohexyl radicals has been studied in the liquid phase by a competitive method. The halogen abstraction data have been put on an absolute basis by comparing rates of the metathetical reactions with the known rate of addition of cyclohexyl radicals to C_2Cl_4. Arrhenius parameters were obtained. The possible application of the Evans–Polanyi relationship to chlorine atom abstraction reaction from CM is considered. (auth)

3090 FREE-RADICAL COUPLING, CLEAVAGE, AND REDOX REACTIONS IN ^{60}Co GAMMA RADIOLYSIS OF AQUEOUS METHYL ACETATE. Effects of Additives. Bernath, T.; Parsons, G. H. Jr.; Cohen, S. G. (Brandeis Univ., Waltham, MA). Contract AT(30-1)-2499; AT(11-1)-3118. J. Amer. Chem. Soc.; 97: No. 9, 2413-2419(30 Apr 1975).

Reaction of methyl acetate with e^-/sub aq/ may lead to $CH_3C(O^-)OCH_3$ (I-), $CH_3C(OH)OCH_3$ (II), and CH_3CO (IIA), and with -OH and H· to $\cdot CH_2CO_2CH_3$ (III), and to $CH_3CO_2CH_2$. (IV). Methyl acetate is consumed, G equals −3.5, and the loss is decreased by formate which scavenges ·H and ·OH, and increased by N_2O which converts e^-/sub aq/ to ·OH. Hydrogen is formed, G equals 1.1, and this is decreased by scavengers for H·, and increased by H^+ which converts e^-/sub aq/ to H·. In radiolysis of 0.027 M methyl acetate, 1.5×10^{22} eV/l., radical combination products are: ethylene diacetate ($CH_3CO_2CH_2CH_2OCOCH_3$) (EDA), G equals 0.48, from IV + IV; methyl beta-acetoxypropionate ($CH_3CO_2CH_2CH_2CO_2CH_3$) (MAP), G equals 0.28, from IV + III; dimethyl succinate (DMS), G equals 0.05, from III + III; and a mixture of methyl acetoacetate and acetonyl acetate (MAA and AA), G equals 0.07. Biacetyl is not observed. Beta-Mercaptopropionic acid, 0.0005 M, prevents formation of coupling products, as it reduces radicals III and IV,

and thiyl radical oxidizes radical II back to methyl acetate. In a damaging cleavage, mercaptan reduces II and IIA to acetaldehyde, which is not formed in the absence of mercaptan. Biacetyl, H^+, N_2O and H_2O_2 remove e^-/sub aq/ and I^-, II and IIA, and suppress MAA-AA; H^+ increases H·, III, and MAP, and DMS; N_2O and H_2O_2 increase ·OH, IV, and EDA. 2-Propanol, HCO_2^-, and CO scavenge ·OH and H· and suppress coupling products. Other sources of ·OH, Fenton's reagent and H_2O_2-uv, lead to EDA, MAP, and DMS with a high IV/III ratio. H· preferentially attacks acyl C–H; ·OH preferentially attacks alkoxyl C–H. Cleavage products (acetic acid, G approximately 1.5; methanol, G approximately 1.0) and small yields of methane and formaldehyde are found. Scavengers of e^-/sub aq/ or of H· and ·OH decrease acetic acid by half. Scavenging of all three fragments prevents formation of acetic acid, and hydrogen peroxide increases it. Radicals II and IIA may lead to 3/4 of the acetic acid, IV to the remainder. Oxidation of them, largely by radical III, and in part by H_2O_2, is the suggested mechanism. Much of radical III is reduced back to methyl acetate. Cu^{2+} Cu^{1+} strongly decrease coupling products and increase acetic acid, probably oxidizing IV and reducing III. Yields of radicals involved in formation of coupling products and acetic acid are estimated: G(II and IIA) equals 1.2; G(III) equals 1.4; G(IV) equals 1.7. Part of the radicals, G approximately 1.6, regenerate methyl acetate by self-repair reduction of IV and III by II. Deuterium is introduced into methyl acetate during radiolysis in D_2O. (auth)

3091 RESONANCE RAMAN AND ELECTRONIC ABSORPTION SPECTRA OF O_3^- IONS IN γ-IRRADIATED $KClO_3$ AND $NaClO_3$. Bates, J.B.; Pigg, J.C. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Chem. Phys. 62: No. 10, 4227-4239 (15 May 1975).

Resonance Raman and electronic absorption spectra have been measured for the ozonide ion, O_3^-, produced in single crystals of $KClO_3$ and $NaClO_3$ by irradiation with γ rays. The O_3^- ions are oriented in four to six symmetrically nonequivalent positions in $KClO_3$ and appear to be oriented in two nonequivalent positions in $NaClO_3$. Differences between the nonequivalent orientations affect both the ground and excited electronic states of O_3^- as well as its ground vibrational states. The progressions of ν_1 observed in the electronic spectra show that the vibrational spacing of ν_1 in the excited electronic state is about 857 cm^{-1} as compared with the ground state spacing of about 1020 cm^{-1}. Measurements of relative Raman intensities obtained with different exciting lines indicates that excitation near the center of a vibronic transition (0–π) produces extra enhancement of the intensity of the $s\nu_1$ vibrational transition. (auth)

3092 IONIZATION IN THE TRACK OF A HIGH-ENERGY ELECTRON IN HYDROCARBON LIQUIDS; STUDY OF POSITIVE AND NEGATIVE ION SCAVENGING USING NANOSECOND PULSE RADIOLYSIS. Zador, E.; Warman, J.M.; Hummel, A. (Interuniversity Reactor Institute, Mekelweg 15, Delft, The Netherlands). J. Chem. Phys. 62: No. 10, 3897-3906 (15 May 1975).

The lifetime distribution of the charged particles in the track of a high-energy electron in cyclohexane and isooctane has been considered. Results on the decay of biphenyl ions in solutions of biphenyl obtained by means of pulse radiolysis with nanosecond time resolution have been compared with lifetime distributions calculated from the concentration dependence of the steady state scavenging, using recently determined absolute rate constants for reaction of excess electrons and mobilities of the charged species. The discrepancy is relatively small for cyclohexane but large for isooctane. It is concluded that the scavengers considerably affect the initial spatial distribution of the charged species in the track. The kinetics of the reaction of the positive species in cyclohexane and isooctane with biphenyl, TMPD, and pyrene has been considered. It has been concluded that the mobile positive species in cyclohexane reacts with pyrene with a rate constant of 5×10^{11} $mol^{-1}s^{-1}$, and has a lifetime of 50 ns. In isooctane no evidence for the existence of a mobile positive species has been obtained. (auth)

3093 PROTSESSY IONNOI POLIMERIZATSII. (Processes of Ion Polymerization). Erusalimskii, B. L.; Lyubetskii, S. G. Leningrad; Izdatel'stvo Khimiya (1974). 256p.

The reactions for the formation of polymers under the influence of anion, cation, and ion-coordination initiators are systematized. The regularties in the formation reactions of macromolecules during the polymerization of unsaturated and heterocyclic monomers are examined. Examples are given of the use of the reactions of ion polymerization for industrial purposes. One chapter is devoted to radiation-induced ion polymerization. (tr-auth)

3094 ANNEALING OF CHEMICAL RADIATION DAMAGE IN SODIUM AND POTASSIUM PERCHLORATES. Das, B. K.; Mohanty, S. R. (Utkal Univ., Bhubaneswar, India). Radiat. Eff.; 23: No. 4, 271-277(1974).

Kinetics of thermal annealing of damage in γ-irradiated sodium and potassium perchlorates was studied. Whereas 64% of the ClO_3^- forms ClO_3^-, the remainder presumably forms ClO_4^-. In each case, thermal annealing is a combination of a first-order and a second-order process. The damage in potassium perchlorate anneals also on exposure to light. The mechanism is first order with a threshold at 39.3 kcal. (auth)

3095 PULSE RADIOLYSIS OF METHANOL AND ETHANOL. Acid-Base Behaviour of Hydroxymethyl and Hydroxyethyl Radicals. Johnson, D. W.; Salmon, G. A. (Leeds Univ., Eng.). J. Chem. Soc., Faraday Trans., I; 71: No. 3, 583-591(1975).

Pulse radiolysis of N_2O-saturated alkaline methanolic and ethanolic solutions indicates that at room temperature the equilibria $R^1R^2\dot{C}OH^- + R^1R^2CHO^- \rightleftharpoons R^1R^2\dot{C}O^- + R^1R^2CHOH$ are rapidly established with K_2 = 2120 ± 235 and 3280 ± 340 for $\cdot CH_2OH$ and $CH_3\dot{C}HOH$ radicals in their respective parent solvents. The decays of the radical anions obey second-order rate laws in both solvents and rate constants have been obtained for the bimolecular reactions involving the neutral and basic forms of the radicals. Experiments with ethanolic acetaldehyde solutions indicate that $k_{-2} = 6\times10^6$ $dm^3mol^{-1}s^{-1}$ and hence $k_2 = 1.8\times10^{10}$ dm^3 $mol^{-1}s^{-1}$. (auth)

3096 LOW TEMPERATURE PULSE RADIOLYSIS OF CONCENTRATED AQUEOUS SOLUTIONS. Dry Electron Capture Efficiencies and Tunnelling Processes of Trapped Electrons in 9.5 mol dm^{-3} LiCl and 10 mol dm^{-3} OH^- Solutions. Buxton, G. V.; Kemsley, K. G. (Leeds Univ., Eng.). J. Chem. Soc., Faraday Trans., I; 71: No. 3, 568-582(1975).

The spectra and reactions of trapped electrons produced by pulse radiolysis in 9.5 mol dm^{-3} LiCl and 10 mol dm^{-3} OH^- (5 mol dm^{-3} NaOH + 5 mol dm^{-3} KOH) solutions have been studied. In each case as the temperature is lowered the spectra of e_t^- first narrow and shift to the blue between 300 and 200°K, and then broaden and shift back to the red between 200 and 150°K. Reactive solutes descrease $G(e_t^-)$, and this is attributed to the capture of electrons before they become trapped. Relative capture efficiencies for a number of solutes have been calculated. Trapped electrons react with solutes even when diffusion cannot occur. In common with other workers we attribute this to tunnelling reactions of e_t^-. However, the tunnelling rates are quite different in the two media, and the differences are rationalized in terms of a trap-to-trap and trap-to-solute tunnelling mechanism. (UK)

3097 PULSE RADIOLYSIS STUDY OF MONOVALENT CADMIUM, COBALT, NICKEL, AND ZINC IN AQUEOUS SOLUTION. I. Formation and Decay of the Monovalent Ions. Buxton, G. V.; Sellers, R. M. (Leeds Univ., Eng.). J. Chem. Soc., Faraday Trans., I; 71: No. 3, 558-567(1975).

The spectra and extinction coefficients of the hyper-reduced metal ions Cd^+, Co^+, Ni^+ and Zn^+ produced in the pulse radiolysis of aqueous solutions of the corresponding divalent ions (M^{2+}) have been measured, and the reactions of these species have been investigated in the absence of oxidising solutes. In the absence of OH scavengers M^+ (except Ni^+) decays by second-order kinetics at approximately the diffusion controlled rate, and the decay is attributed to reoxidation of M^+ by OH. Evidence for the oxidation of Co^{2+} by OH is presented. In the presence of formate ion, methanol, isopropanol or t-butanol as OH scavengers the decay of M^+ is slower, varies with the scavenger used and is only approximately second order. Spectra of long-lived products are presented. It is suggested that M^+ can react with itself and with the radical formed from the organic solute. (auth)

3098 HIGH INTRINSIC TL OF CaF_2:Dy TO UV LIGHT. Bassi, P.; Busuoli, G.; Rimondi, O. (Comitato Nazionale per l'Energia Nucleare, Bologna). Health Phys.; 28: No. 4, 470-471 (Apr 1975).

Thermoluminescent material CaF_2:Dy (TLD 200) preirradiated with γ rays shows transferred thermoluminescence when exposed to uv light. Since the phosphor must be preirradiated everytime it is employed as a uv dosimeter it has limited application in this field. However, it is reported here that TLD-200 takes on a high intrinsic sensitivity to uv light when it is treated in air at a temperature of 900 to 1000°C. The maximum sensitivity so obtained is about 500 times higher thar that of TLD-200 not treated and about 10 times higher than hat obtained with a γ preirradiation of 0.2 krad. A TLD-200 detector so treated can be reused without loss of sensitivity. (UK)

3099 UNSTABLE INTERMEDIATES. CXXXVIII. The Formation of β-Bromoalkyl Radicals by the Action of γ-Rays on Various Organic Bromides: Electron Spin Resonance Spectra at Low Temperature. Lyons, A. R.; Neilson, G. W.; Mishra, S. P.; Symonds, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 71: 363-371(1975).

Exposure of ethyl, n-propyl, n-butyl and t-butyl bromide to ^{60}Co γ-rays at 77°K gave, in addition to alkyl radicals, species identified as β-bromo radicals by their ESR spectra. That obtained from t-butyl bromide was the best defined, the radical being

$Me_2\dot{C}CH_2Br$ rather than the expected $H_2\dot{C}CMe_2Br$. This species had a (Me) = 13 G, and $A_{iso}(^{81}Br) \approx 296$ G. Both hyperconjugation and p-p homoconjugation are invoked to explain the results. Similar β-bromo radicals, $MeCH-CH_2Br$ and $H_2C-C(Br)RCO_2H$, were formed from allyl bromide and α-bromo acrylic acid. (auth)

3100 GAMMA IRRADIATION OF CYCLITOLS. I. Possibilities of dc-Separation of Aqueous Reaction Mixtures: Qualitative Determination of Decomposition Products. Bancher, E.; Washuettl, J.; Schmidt, B.; Riederer, P.; Wurst, F. (Technische Hochschule, Vienna). J. Radioanal. Chem.; 24: No. 2, 295-301 (1975). (In German).

With different TLC-methods the R_f-values of myo-inosite, myo-inosose (2), (l) epi-inosose, tetrahydroxy-p-chinon, d,l-myo-inososе-2-phenylosazon, d,l-xylo-4,5,6-trihydroxy-2-oxo-1,3 bis(phenylhydrazono)-cyclohexaneare qualitatively determined. (auth)

3101 OPTICAL STUDIES OF RADIATION PROCESSES IN PHOSPHATE GLASSES. Kolditz, L.; Klein, W. (Humboldt-Univ., Berlin). Z. Anorg. Allg. Chem.; 412: No. 3, 215-226(Mar 1975). (In German).

In the system alkaline oxide/alkaline earth oxide/Tl_2O/P_2O_5 a stable glass has been found which shows an optimal effect on radiation. An interpretation of absorption bands after radiation and of the course of radiation chemical processes of thallium is given by UV-VIS-spectroscopy in dependence of composition (including electron-donors and -acceptors), radiation doses, atmosphere, by studying optical and thermal bleaching, by fluorescence and thermoluminescence spectroscopy. (auth)

3102 FORMATION, STABILIZATION AND LUMINESCENT DECAY OF CHARGED SPECIES IN PHOTO- R γ-IONIZED MOLECULAR SOLID SOLUTIONS. Bernas, A.; Blais, J.; Gauthier, M.; Grand, D.; Truong, T. B. (Univ., Paris). Int. J. Radiat. Phys. Chem.; 6: No. 5, 401-421(Dec 1974).

Transitory charged species produced at 77°K, either by photoionization of solutes in solid solutions or γ-irradiation of pure rigid solvents, were studied at the stage of their neutralization by recording the optically stimulated recombination luminescence. Three distinct aspects of separated ion pair formation and decay were examined. (I) The photoionization threshold energies I_{sol} of a solute (TMPD or tryptophan) in various solid solvents have been determined from plots of stimulated luminescence (SL) intensity vs exciting light frequency. Systematic experiments showed that (a) the more polar the solvent, the lower is I_{sol}, (b) in the case of non-polar matrices, the more globular the solvent molecule, the lower is I_{sol}, and (c) for these non-polar solvents, I_{sol} is 0.7 to 0.9 eV higher in solid solvents than in the corresponding liquids. Besides the formation of separated ion-pairs, the existence of compact ion-pairs seems to be evidenced by a specific spontaneous long-lived luminescence located around 430 nm, between the fluorescence and phosphorescence of the solute. (II) The negatively charged species can be identified from the SL excitation spectra. Two types of physically trapped electrons have thus been differentiated in more or less relaxed 3MP and MCH glasses. If optically detrapped, the released electrons may then be captured by 3 methylpentyl- or methylcyclohexyl ($R_{3/CH}$) radicals. (III) The dissociative or non-dissociative character of the neutralization process as well as the nature of electronically excited dissociation fragments can be deduced from the SL emission spectra. This has been considered in the case of γ-irradiated light and heavy polycrystalline ices. For both ices, the emission intensity is maximum around 380 to 390 nm. Since the detrapped electron has only about 1 eV initial kinetic energy, an electronic excitation of OH or OH^- as well as temporary H_2O^- formation may be disregarded. H_2O lower triplet formed upon H_3O^+ dissociative neutralization thus remains the most plausible emitting species. (auth)

3103 ESTIMATED DISTRIBUTIONS OF ELECTRONIC REDOX LEVELS IN aq/e^-_{aq}, H^+_{aq}/H_{aq} AND SOME OTHER SYSTEMS. Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Sektor Strahlenchemie). Ber. Bunsenges. Phys. Chem.; 78: No. 10, 1078-1084(Oct 1974).

A crude estimate of the distributions of occupied and unoccupied electronic levels of the redox systems aq/e^-_{aq} (aq: water traps) and H^+_{aq}/H_{aq} was made using known optical and thermodynamic data of the species involved. The distribution of unoccupied levels in H^+_{aq}/H_{aq} is thought to be rather narrow, while that of the occupied levels is wide. Under these circumstances, the hydrated electron may be expected to react with H^+_{aq} via tunneling with a nearly diffusion controlled rate. The reaction of the mobile electron with H^+_{aq} is expected to be rather slow because of the low density of unoccupied states of the system H^+_{aq}/H_{aq} at the energy level of e^-_{mobile}. Similar considerations were applied to the redox systems H_{aq}/H^-_{aq} and OH_{aq}/OH^-_{aq}. In both cases, the distribution of unoccupied levels was very broad. The polarograms of H and OH recently measured in the 10^{-5} s range may be understood in terms of these estimated distribution functions. Ions of high negative redox potentials such as Mg^{2+}_{aq} are expected to be more reactive towards hydrated electrons. (auth)

3104 PHOTOCHEMICAL TRANSFORMATIONS OF ALKYL RADICALS AT 77°K. Mel'nikov, M. Ya.; Sklyarenko, V. I.; Fok, N. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 218: No. 4, 875-877(1 Oct 1974). (In Russian).

The photolysis of alkyl radicals formed during gamma irradiation of glassy hydrocarbons at 77°K was studied. The following hydrocarbons were used: 3-methyl-pentane, 3-ethyl-pentane, and 4-methyl-heptane. Conversion of the alkyl radicals was observed by EPR, optical spectroscopy, mass-spectroscopy and gas chromatography. (tr-INIS)

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3105 (AEC-tr-7533/3) NUKLEONIKA. Translation of Nukleonika; 19: No. 3, 157-274(1974). 112p. (TT-74-54003/3). Dep. NTIS $8.75.

3106 THIRTY YEARS OF NUCLEAR CHEMISTRY IN POLAND. Minczewski, J.; Siekierski, S.; Zagorski, Z. P. (Inst. of Nuclear Research, Warsaw). Nukleonika; 20: No. 1, 15-23 (1975).

Short survey of advances in nuclear chemistry in Poland during past thirty years is given. The main fields described are: (i) Radiochemistry, pure and applied to the production of isotopes and reprocessing of nuclear fuel; (ii) Basic radiation chemistry, and applied to problems of radiation processing of different materials in selected purposes of sterilization, grafting and cross-linking; (iii) Radioanalytical chemistry with activation analysis and separation methods, as well as, instrumental analysis connected closely to nuclear chemistry. Other achievements, like application of radioactive indicators in the science, medicine and industry as well as in analysis and processing of ores, etc. are only briefly mentioned. (auth)

Hot-Atom Chemistry

Refer also to abstract 3089.

3107 CHEMICAL BEHAVIOUR OF THE Zr AND Y RECOIL ATOMS IN Zr AND Y ACETYLACETONATES IRRADIATED WITH 660 MeV PROTONS. Islamova, Kh.; May, N. G.; Ronneau, C.; Zaitseva, N. G. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem.; 37: No. 4, 865-868(Apr 1975).

The chemical states of zirconium and yttrium recoil atoms formed by irradiation of Zr and Y acetylacetonates with 660-MeV protons were identified by chromatography and sublimation. The yield of recoil atoms in different chemical forms is shown to depend on both experimental conditions of the irradiation and the method of analysis, which suggests that the fate of the recoil species is substantially determined by its thermal reactions. (auth)

3108 MODEL FOR FAST SELECTIVE ON-LINE SEPARATION OF Zr AND Nb IN THE MILLISECOND RANGE. Steinwandter, H. (Technische Univ. Darmstadt (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 2, 611-613(1 Mar 1975). (In German).

After 10 ms, with $ZrCl_4$ as chlorinating agents, no $^{99}NbCl_5$ is formed, whereas 40% of the ^{99}Zr recoil atoms are chlorinated to $^{99}ZrCl_4$. (auth)

Properties of Radioactive Materials

Refer also to abstracts 3021, 3035, 3041, and 4421.

3109 (DP-MS-74-64) NEPTUNIUM(III) AND PLUTONIUM (III) CYCLOOCTATETRAENYL BROMIDES AND IODIDES. Karraker, D. G.; Stone, J. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 11p. (CONF-750410-4). Dep. NTIS $4.00.

From 169th national meeting, American Chemical Society; Philadelphia, Pennsylvania, USA (6 Apr 1975).

Np(III) and Pu(III) compounds of the composition $M(COT)X \cdot nTHF$ were prepared by reacting equivalent quantities of K_2COT and MX_3 in tetrahydrofuran (THF) solution (COT equals $C_8H_8^{2-}$, the cyclooctatetraenyl ion; M equals Np^{3+} or Pu^{3+}; X equals Br^- or I^-). These compounds are oxidized violently by air and decomposed by water. The compounds were characterized by chemical analysis and x-ray powder diffraction data. A preliminary Moessbauer measurement verified the +3 valence of Np^{3+} in Np(COT) I · xTHF

and indicated only a small covalent contribution to the bonding. Magnetic susceptibility results suggest a low-symmetry field on the actinide (III) ion in these compounds. (auth)

3110 (JUL-1145-NC) FLUORINE-18 LABELLING OF FATTY ACID ESTERS USING EXCHANGE RESINS IN GAS CHROMATOGRAPHIC COLUMNS. Karim, H. M. A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Nuklearchemie). Dec 1974. 35p. Dep. NTIS (US Sales Only) $4.75.

Fluorine-18 was produced via the reaction chain $^{6}Li(n,\alpha)t$, $^{16}O(t,n)^{18}F$ by reactor irradiation ($\phi_{th} = 6.7 \cdot 10^{13}$ cm^{-2}sec^{-1}) of Li_2CO_3 (95% enriched) ^{6}Li. More than 90% of carrier-free ^{18}F could directly be recovered by repeated extractions with water within 10 minutes. A simple apparatus was used for simultaneous extraction of ^{18}F and fast loading of an exchange resin with $^{18}F^-$ with or without carrier. Dowex 1 × 4 in the acetate form was found to be best suited for a gas phase ^{18}F-for-Br exchange in α-bromofatty acid esters. The ^{18}F-loaded exchange resin was brought into a gas chromatographic column followed by an analytical column for the separation of the ^{18}F-labelled product from the unchanged mother compound. The technique combines synthesis and purification and allows a fast and carrier-free production of ^{18}F-α-fluorofatty acid esters with boiling points up to about 300°C. Carrier-free $CH_2{}^{18}FCOOC_2H_5$ and $CH_3(CH_2)_2CH^{18}FCOOCH_3$ were synthesized by this technique for the first time. The exchange yield of the former compound increased from 49% at 140°C to 64% at 170°C, while that of the latter compound increased from 9% at 160°C to 39% at 190°C. The effects of contact times and the concentration of the substrates injected on the yield of the α-fluorofatty acid esters were also studied. All these ^{18}F-labelled esters and their derivatives are of potential importance in clinical nuclear medicine as well as for the development of new radiopharmaceuticals. (auth)

3111 (ORNL-tr-2938) INVESTIGATION OF THE STABILITY OF THE FLUORINATION PROCESS OF URANOUS-URANIC OXIDE IN A FLUIDIZED BED. Lebedev, O. G.; Murashov, M. V.; Prusakov, V. N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1973. Translation of IAE-2328. 27p. Dep. NTIS $4.50.

The phenomenon of the breakdown of the stability of fluidization observed during fluorination of the mixed uranium oxide U_3O_8 in a chemically inert fluidized bed (Al_2O_3) at a high concentration of the reagents, was studied in an experimental installation. Analysis of the formed agglomerates indicated that the sintering was caused by the overheating of the particles of the solid reagent which initiated an accelerated fluorination of the aluminum oxide particles, subsequently binding them to the reaction products. On the basis of the theory of the thermal behavior of heterogeneous exothermic reactions, and also of the "bundle" concept of fluidization, it was found that critical conditions prevailed in the system, causing the breakdown of thermal behavior of the reacting particles in the high temperature range. It was found experimentally that there is a concentration range of the reagents at which the fluorination process takes place in a stable manner. The data were obtained at 500°C, at a flow rate of 0.11 to 0.20 m/sec of the fluidizing agent, with C/sub F_2/ equals 40 to 80 vol percent and C/U_3O_8/S/sub U_3O_8/ equals 10 to 80 m^2 per kg of the fluidized bed. (auth)

3112 TECHNETIUM-99m–TETRACYCLINE: PREPARATION, BIOLOGICAL DYNAMICS, AND UPTAKE IN DAMAGED AND NORMAL SKELETAL MUSCLE. Robinson, G. D.; Battaglia, D. J. (California Univ., Los Angeles). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 147-152(Apr 1975).

Recently, a ^{99m}Tc-tetracycline complex has been proposed as a kidney scanning agent with potential for use in myocardial infarct imaging. The chemistry of preparation of ^{99m}Tc-tetracycline has been studied and the biological dynamics of this chelate in the rat has been measured. In addition, the differential uptakes of ^{99m}Tc-tetracycline in damaged and healthy rat skeletal muscle, have been determined. The tetracycline complex of ^{99m}Tc is prepared by reduction of ^{99m}Tc-pertechnetate with an Sn(II)-tetracycline complex in the presence of excess tetracycline in a deoxygenated aqueous solution. Preparations containing 1 mg of $SnCl_2$ and 30 mg of tetracycline hydrochloride contain less than 10% free pertechnetate and virtually no free, reduced ^{99m}Tc. The labeled complex is stable for up to several hours at room temperature. The biological dynamics of ^{99m}Tc-tetracycline were studied by tissue sampling at 5, 15, 30, and 60 min post injection. The agent showed moderate liver uptake (≅ 10%) and substantial urinary clearance (up to 30%) during the first hour. At 18 hr post injection, rat thigh muscle which had been damaged by repeated pinching with forceps showed uptakes of ^{99m}Tc-tetracycline which were 7 to 9 times greater than the contralateral, normal thigh muscle. If similar ratios of concentration occur in damaged vs normal myocardium, imaging of the abnormal regions may be possible. (auth)

3113 ^{11}C-LABELLING OF OVINE LUTEINIZING HORMONE BY REDUCTIVE METHYLATION. Marche, P. (CEN de Saclay, Gif-sur-Yvette, France); Marazano, C.; Maziere, M.; Morgat, J. L.; de la Llosa, P.; Comar, D.; Fromageot, P. Radiochem. Radioanal. Lett.; 21: No. 1-2, 53-59(14 Apr 1975).

The ^{11}C-methyl labelling of the luteinizing hormone has been accomplished by reacting the hormone with ^{11}C-formaldehyde in the presence of $NaBH_4$. ^{11}C-formaldehyde was prepared by oxidation of ^{11}C-methanol obtained from $^{11}Co_2$. Under the mild experimental conditions used, all ^{11}C-methylated hormone was obtained with a specific radioactivity of 20 Ci/mmole and directly utilizable for in vivo studies. (auth)

3114 METHOD FOR CALIBRATING ^{32}P RADIOPHARMACEUTICALS. LeBlanc, A. D.; Johnson, P. C. (Texas Medical Center, Houston). Health Phys.; 28: No. 4, 477-479(Apr 1975).

Experience with supplier assay accuracy of ^{32}P samples for human use and with methods which may be used to check this accuracy is presented. It is shown that a significant fraction of the ^{32}P shipments considered had large errors which could have had grave results if used unchecked. The first method of checking using scintillation counting of aliquots of the parent solution was time consuming and so a second method was devised which involved counting a 1 cm^3 sample of a dilution of the parent solution, drawn into a disposable syringe, directly in the well of a commercial dose calibrator. Comparative results are presented. (UK)

3115 SEPARATION OF ^{81g}Se IN A MIXTURE OF SELENIUM RADIOISOTOPES. Fernandez, M.; Bulbulian, S. (Centro Nuclear de Salazar, Mexico). Radiochem. Radioanal. Lett.; 21: No. 1-2, 79-85(14 Apr 1975).

A convenient method for obtaining radiochemically pure ^{81g}Se is described. It is based on the reduction of selenium(VI) to selenium(IV) as a result of the chemical effects accompanying the $^{81m}Se \rightarrow {}^{81g}Se$ isomeric transition in potassium selenate solutions. (auth)

3116 EQUILIBRIUM STUDIES OF MIXED-LIGAND COMPLEXES OF URANYL ION WITH MONO- AND DICARBOXYLIC ACIDS IN AQUEOUS SOLUTION. Balakrishnan, M. S.; Santappa, M. (Madras Univ., India). J. Inorg. Nucl. Chem.; 37: No. 5, 1229-1234(May 1975).

The stability constants of the ternary UO_2^{2+} complexes involving monobasic acids, propionic, pyruvic and phenoxy acetic acids and secondary ligands were determined by pH titrations. Most of the ternary complexes with the primary ligands, propionic and pyruvic acids, are more stable than would be expected from statistical considerations. The stability values show the discriminating qualities of UO_2^{2+}-monobasic acid 1:1 complexes toward the second ligand to be coordinated. The overall stability is found to be dependent on the binary stabilities. The formation of ternary complex is also dependent on the product of acid dissociation constants of the secondary ligands. (auth)

3117 DISTRIBUTION OF THE DAUGHTER SPECIES RESULTING FROM CHELATES BY β^--DECAY IN TWO-PHASE SYSTEMS. Macasek, F.; Mikulaj, V.; Kopunec, R. (Komenskeho Univerzita, Bratislava). pp 451-458 of Solvent Extraction. London; Society of Chemical Industry (1974).

From international solvent extraction conference; Lyon, France (8 Sep 1974).

The β^--decay of a radionuclide bound in a neutral chelate gives rise to a molecular ion containing the daughter nuclide even in a non-polar organic phase. The daughter species in the $^{99}Mo-{}^{99m}Tc$, $^{144}Ce-{}^{144}Pr$ and $^{234}Th-{}^{234m}Pa$ decays may be unusual in respect to their coordination and oxidation states. Their steady-state distribution is of interest, generally differing from a conventional extraction equilibrium of the daughter elements (Tc, Pr, Pa) in their normal valency states in the same systems, and a model for this distribution is proposed. (auth)

3118 FORMATION OF FERROCYANIDES. IV. Th(IV), Nd(III), UO_2(II), AND Hg(II). Bellomo, A.; De Marco, D.; Casale, A. (Univ., Messina, Italy). Talanta; 22: No. 2, 197-200(Feb 1975).

The stoichiometry of the reaction between ferrocyanide and thorium, neodymium, uranyl ion and mercury(II) has been investigated. The first three give single products irrespective of the order of addition of reagents, but the last does not. If mercury(II) is added to ferrocyanide, $Hg_2Fe(CN)_6$ is obtained, but if ferrocyanide is added to mercury(II) various cyanide complexes of mercury are formed. The K_{sp} values for the precipitates are reported. (auth)

3119 PREPARATION AND CRYSTAL STRUCTURE OF BIS(PROTONATED, 2,6-DIACETYLPYRIDINE BIS(PHENYLHYDRAZONE) URANYL TETRACHLORIDE, CH_3CN. Garaziani, R. (Univ., Padua); Bombieri, G.; Forsellini, E.; Paolucci, G. J. Cryst. Mol. Struct.; 5: No. 1, 1-14(Jan 1975).

The reaction of 2,6-diacetylpyridine-bis(phenylhydrazone), L, with commercial uranyl chloride under a variety of different conditions gave only complexes of the type $[2LH]^{2+}[UO_2Cl_4]^{2-}$, xCH_3CN (x = 1 or 2). The structure of the title compound was determined by x-ray analysis. The crystals are triclinic, space group $^{*}P\bar{1}$, a = 12.77(1), b = 23.12(2), c = 8.11(1) Å, α = 94.33(3)°, β = 89.43(3)°, γ = 98.22(3)° and Z = 2. The structure was solved by Fourier methods, and refined by least-squares to R = 0.074 for 5210 reflections which were measured on an automatic diffractometer. The $[UO_2Cl_4]^{2-}$ anions have approximately $\frac{4mm}{m}$ (D_{4h}) symmetry, with the uranyl group perpendicular to a plane in which the four chlorine atoms occupy the corners of a square. The organic cations are approximately planar. Shortening in the C–N (chain) bond distances suggests the presence of a mesomeric effect extended over the entire organic system. (auth)

3120 COMPLEXES OF 1-(2-PYRIDYLAZO)-2-PHENANTHROL WITH V(V), Zn(II), Cd(II), Hg(II), Ag(I) AND UO_2(II). Bhoon, Y. K.; Pandeya, K. R.; Singh, R. P. (Univ., of Delhi). Indian J. Chem.; 13: No. 1, 84-85(Jan 1975).

Complexes of 1-(2-pyridylazo)-2-phenanthrol (PAP) with V(V), Zn(II), Cd(II), Hg(II), Ag(I) and UO_2(II) have been prepared. Zn(II), Cd(II) and UO_2(II) form 1:2 and V(V), Hg(II) and Ag(I) 1:1 complexes. All the complexes are diamagnetic, as expected. Tentative structures have been proposed for the complexes. (auth)

3121 OXIDATION OF URANIUM(IV) ACETATE. Singh, M.; Singh, G.; Paul, R. C. (Panjab Univ., Chandigarh, India). Indian J. Chem.; 13: No. 1, 90-91(Jan 1975).

Oxidation of uranium(IV) acetate with chlorine and bromine in dioxane yields new compounds of uranium(VI), of the formulae $Cl_2UO(OAc)_2$, $Br_2UO(OAc)_2$, dioxane and $Br_2UO(OAc)_2$. (auth)

3122 MIXED URANYL COMPLEXES CONTAINING MULTIDENTATE SCHIFF BASES. Vadali, M.; Vigato, P. A.; Casellato, U. (Consiglio Nazionale delle Ricerche, Padua). J. Inorg. Nucl. Chem.; 37: No. 4, 955-961(Apr 1975).

A new class of mixed ligand complexes of uranium(VI) is reported. The complexes have the stoichiometry $[UO_2L(A)]$, where L is a potentially tridentate or quadridentate Schiff base anion and A is an anion which may act as unidentate or bidentate ligand. The configurations of these complexes have been investigated by means of ^1H NMR, ir and uv spectroscopy. The complexes contain heptacoordinated uranium with irregular pentagonal bipiramidal geometry. Conductivity measurements indicate that the complexes are non-electrolytes even in the presence of a large excess of triphenylphosphine oxide. Studies on the relative stabilities of the U–A bonds are reported. The influence of the anion on the stretching frequency of the N–H group of the Schiff base and on the antisymmetric stretching mode (ν_3) of the O–U–O group has been determined. (auth)

3123 URANYL COMPLEXES WITH BIS(β-DIKETONE)DIIMINE. Spectroscopic Studies on the Uranyl Complexes with Bis(acetylacetone)ethylenediimine and Its Derivatives. Kim, B. I.; Miyake, C.; Imoto, S. (Osaka Univ.,). J. Inorg. Nucl. Chem.; 37: No. 4, 963-969(Apr 1975).

Uranyl complexes with the Schiff bases derived from β-diketones and alkyl diamines, such as bis(acetylacetone)ethylenediimine(H_2acen), bis(acetylacetone)-1,2-propylenediimine(H_2acpn), bis(acetylacetone)trimethylenediimine(H_2actn), bis(acetylacetone)-hexamethylenediimine(H_2achn), bis(benzoylacetone)ethylenediimine-(H_2bzen), bis(benzoylacetone)-1,2-propylenediimine(H_2bzpn), bis(benzoylacetone)trimethylenediimine(H_2bztn) and bis(benzoylacetone)hexamethylenediimine(H_2bzhn), have been prepared and studied by ir electronic and NMR spectroscopy. Characteristic ir stretching frequencies (4000 to 200 cm^{-1}) are reported for each complex. It is found from elemental analysis and ir data that bis(β-diketone)diimines behave as the neutral bidentate ligands in the uranyl complexes and all the uranyl complexes have the structural formula UO_2(bis(β-diketone)diimine)$(NO_3)_2$. The vibronic structure of the bands in the visible region becomes obscure only in pyridine, suggesting the stronger interaction between the solvent molecule and uranium(VI) atom. Characteristic proton magnetic resonance spectra of the complexes are also reported. (auth)

3124 EQUILIBRIA IN URANYL CARBONATE SYSTEMS. I. The Overall Stability Constant of $UO_2(CO_3)_3^{4-}$. Cinneide, S. O.; Scanlan, J. P.; Hynes, M. J. (University Coll., Galway, Ireland). J. Inorg. Nucl. Chem.; 37: No. 4, 1013-1018(Apr 1975).

Solutions of 8-hydroxyquinoline in chloroform have been shown to extract the uranyl(VI) ion from aqueous carbonate media and from aqueous solutions of two phenylarsonic acid derivatives, as the species $UO_2(OX)_2HOX$. A method for calculating the overall stability constant, $\beta_{3(c)}$, of $UO_2(CO_3)_3^{4-}$ from the resultant distribution data is outlined. The value obtained is log $\beta_{3(c)}$ = 21.54 ± 0.03 at an ionic strength of 0.1 M. (auth)

3125 PREPARATION, INFRARED CHARACTERIZATION AND THERMAL ANALYSIS OF SOME MONOMERIC AND POLYMERIC URANYL-PYRIDINE-2,6-DICARBOXYLATE ADDUCTS. Degetto, S.; Marangoni, G.; Baracco, L.; Gurrieri, S.; Siracusa, G. (Consiglio Nazionale delle Ricerche, Padua). J. Inorg. Nucl. Chem.; 37: No. 5, 1185-1189(May 1975).

Some monomeric and polymeric uranyl-pyridine-2,6-dicarboxylate chelates with neutral ligands (water, ethylurethane, urea, dimethylsulfoxide, pyridine-N-oxide, allylamine) have been prepared and characterized by ir spectroscopy, elemental analysis, and thermal behavior. The loss of the neutral ligands gives rise to different polymeric intermediates whose probable structures are likely discussed on the basis of a comparative investigation of ir spectra and thermal parameters. (auth)

3126 URANYL COMPLEXES WITH TRICARBONYLCHROMIUM DERIVATIVES. Casellato, U.; Vigato, P. A.; Vidali, M. (Consiglio Nazionale delle Ricerche, Padua). J. Inorg. Nucl. Chem.; 37: No. 5, 1181-1184(May 1975).

Uranyl complexes with the ligands tricarbonylchromium benzoic acid and tricarbonylchromium benzoylacetone have been prepared and characterized in the solid state and in solution. Their ir spectra indicate that in all the complexes there is a pentagonal bipyramidal configuration around the uranium atom. The antisymmetric stretching frequency (ν_3) O–U–O is not significantly affected by the presence of the monodentate ligands and the $Cr(CO)_3$ groups. In addition, in the 2200 to 1800 cm^{-1} carbonilic range, the two bands predicted by the C_{3v} local symmetry are not significantly shifted by coordination to the uranyl group. All the complexes are generally less stable in solution than the corresponding ligands. (auth)

3127 URANYL COMPLEXES WITH P-NITROSO-N,N-DIMETHYLANILINE. Condorelli, G.; Fragala, I.; Giuffrida, S. (Catania Univ., Italy). J. Inorg. Nucl. Chem.; 37: No. 5, 1177-1179(May 1975).

The complexes formed by some uranyl salts with p-nitroso-N,N-dimethyl-aniline have been prepared and characterized by elementary analyses, molar conductances, diffuse reflectance and ir spectral measurements. The p-nitroso-N,N-dimethylaniline acts as monodentate ligand through the NO oxygen atom. The coordinating mode of the anions in the complexes is also discussed. (auth)

3128 LASER RAMAN SPECTRA OF THE URANIUM HEXACHLORIDE MOLECULE AND ANIONS (UCl_6, UCl_6^{-1}, AND UCl_6^{-2}). Shamir, J.; Silberstein, A. (Hebrew Univ., Jerusalem). J. Inorg. Nucl. Chem.; 37: No. 5, 1173-1175(May 1975).

Uranium hexachloride species in which the uranium is in the VI, V, and IV oxidation states were synthesized and their laser Raman spectra studied. The various spectra of UCl_6, UCl_6^{-1} and UCl_6^{-2} show a similar pattern of three lines. These were assigned as ν_1, ν_2 and ν_5, the Raman active vibrations of an octahedral symmetry, O_h. The changes in the frequencies of the respective vibrations were correlated with changes in oxidation states of uranium and with the counter cations in the various salts. (auth)

3129 KINETICS OF OXIDATION OF URANIUM(IV) IN AN ORGANIC MEDIUM BY MOLECULAR OXYGEN. Juznic, K.; Senegacnik, M. (Nuffield Orthopaedic Centre, Oxford). Inorg. Nucl. Chem. Lett.; 11: No. 5, 349-351(May 1975).

Previous studies dealing with the oxidation of uranium(IV) by molecular oxygen have been made in aqueous media. The present work was planned to contribute to the elucidation of the mechanism of the reaction by data for the reaction rate in an organic medium. Organic solutions of uranium(IV) sulfate were prepared by extraction from aqueous sulfate media into 0.2 M TOA in toluene. Experimental details are given. The results are presented and discussed. (auth)

3130 THE RAMAN SPECTRUM OF $(TMA)_2UCl_6$ AND $(TMA)_2SnCl_6$ CRYSTALS AND OF TMACl IN SOLUTION. von der Ohe, W. (Department of Physics, University of California, Los Angeles, California 90024). J. Chem. Phys. 62: No. 10, 3933-3945 (15 May 1975).

The Raman spectrum of $(TMA)_2UCl_6$, not reported previously, is presented and the assignments of the observed bands to normal modes of vibration are discussed based on polarized room temperature scans of single crystals. Seventeen of the eighteen fundamental vibrational bands and seven nonfundamental ones are identified. The missing fundamental vibrational band, containing mainly methyl internal symmetric stretching motions, is at least three orders of magnitude weaker than another band

composed of the same methyl internal motions. Five totally symmetric nonfundamental bands are resolved near 3000 cm^{-1}. It is suggested that they interact by Fermi resonance with the highly intense totally symmetric methyl stretching vibration. Their proposed assignments imply that one of the nonfundamental bands is an overtone of a combination level, thus involving four vibrational quanta. Another one of these bands is assigned to a combination level involving three different vibrational quanta. Light scattering by three and four phonon excitations has not been reported before, except in resonance Raman scattering. An unpolarized Raman spectrum of $(TMA)_2SnCl_6$ is shown and the bands are assigned based on the close correlation with the $(TMA)_2UCl_6$ spectrum. The Raman spectrum of TMACl in solution is reexamined. Four of the frequencies reported previously could not be verified, and five bands of this spectrum, including a fundamental one, are reported here for the first time. The polarization information of the latter spectrum is completed. The crystal structures of $(TMA)_2UCl_6$ and $(TMA)_2SnCl_6$ are discussed. Four variations of the structure compatible with O^1_h, the space group suggested for both crystals by x-ray investigations, are described. (auth)

3131 NEW DETERMINATION OF THE ENTHALPY OF SOLUTION OF CURIUM METAL AND THE ENTHALPIES OF FORMATION OF $Cm^{3+}(aq)$ AND $CmCl_3(s)$. Fuger, J. (Liege Univ.); Reul, J.; Muller, W. Inorg. Nucl. Chem. Lett.; 11: No. 5, 265-275(May 1975).

The enthalpy of solution of curium metal (dhcp structure) in 1M HCl has been measured at 298.15 ± 0.1 K, giving a value of -614.5 ± 4.5 kJ mol^{-1}. From this value, the standard enthalpy of formation of $Cm^{3+}(aq)$ is deduced as -615 ± 5 kJ mol^{-1} and, using reasonable entropy estimates, the standard potential of the Cm(0)/Cm(III) couple is calculated to be 2.07 ± 0.03 V. Calculation also yields a value of -971 ± 6 kJ mol^{-1} for the standard enthalpy of formation of $CmCl_3(s)$ at 298 K. (auth)

3132 GENERAL METHOD FOR LABELING PROTEINS WITH ^{11}C. Straatmann, M. G.; Welch, M. J. (Washington Univ., St. Louis). J. Nucl. Med.; 16: No. 5, 425-428(May 1975).

A method for labeling proteins with ^{11}C has been developed. The method consists of adding ^{11}C-formaldehyde (derived from $^{11}CO_2$ by catalytic oxidation of ^{11}C-methanol) to a buffered protein solution, followed by reduction of the resulting formaldehyde-protein adduct with aliquots of sodium borohydride. Separation of the desired product is achieved simply and efficiently using high-speed liquid chromatography or, in the case of fibrinogen, by ammonium sulfate precipitation. This mild technique leads to high yields of labeled protein and is adaptable to the labeling of proteins and peptides or other molecules which contain a free amino group and which are stable at pH 8. (auth)

3133 A CONTINUOUS ION-EXCHANGE PROCESS FOR THE PURIFICATION OF PLUTONIUM NITRATE SOLUTIONS. Boecker, H. I.; Evers, H.; Knoch, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Leopoldshafen (F. R. Germany)). KFK Nachr.; 6: No. 4, 28-30(1974). (In German).

Spherical resin particles are continuously led in counter current to the liquid phase in the exchange column. By means of this the penetration capacity can be considerably increased and operational disturbance due to clogging as a result of the resin caking can be avoided. (GE)

3134 RADIOCHEMICAL STUDY OF THE REACTION OF FREE METHYL CATIONS WITH ETHERS. Nefedov, V. D.; Sinotova, E. N.; Akulov, G. P.; Korsakov, M. V. (Leningrad State Univ.). Zh. Org. Khim.; 10: No. 8, 1586-1590(Aug 1974). (In Russian).

For English translation see the journal J. Org. Chem. USSR.

A study was made of the gas-phase reactions of free methyl cations (CT_3^+), which were obtained as a result of nuclear-chemical transformations in completely tritiated methane (CT_4), with simple ethers. The products of these reactions are tritium-containing simple ethers CT_3OR. The product yields depend on the ionization potentials of the radical R. (tr-auth)

3135 CITRATE COMPLEXES OF U(IV). Shalimov, V. V.; Kliko, N. I.; Zeitsev, B. N.; Tebelev, L. G.; Nikolaev, V. M. pp 3-7 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

A spectrophotometric study was made of the complex formation of U(IV) with citric acid in perchloric acid medium. Two soluble complex forms were observed, of which one was identified as the citric acid complex $UHCit^{2+}$, formed by the reaction $U^{4+} + H_3Cit \rightleftharpoons UHCit^{2+} + 2H^+$ with an equilibrium constant of $K = 7.0 \pm 0.5$. The effect of the acidity of the medium and the ratio of the U^{4+} and citric acid concentrations on the precipitate yield was shown. It was established that three types of precipitates are formed, differing in composition and color, as a function of pH. (tr-auth)

3136 DOUBLE SULFATES OF U(III) AND SOME OF THEIR PROPERTIES. Vyatkina, A. S.; Serebrennikov, V. V. pp 7-10 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

Double sulfates of U^{3+} were precipitated with the composition $NaU(SO_4)_2 \cdot 2H_2O$, $K_3U(SO_4)_3 \cdot 2H_2O$, $RbU(SO_4)_3 \cdot 2H_2O$, and $Cs_3U(SO_4)_3 \cdot 2H_2O$. Their densities at 25°C in g/cm^3 were 3.23, 3.68, 3.72, and 4.68 respectively. Their ir spectra, x-ray structural characteristics, and thermal stability were studied. The presence of water in the internal sphere of the complex was established. (tr-auth)

3137 MIXED URANYL COMPOUNDS WITH DIMETHYLSULFOXIDE. Nikol'skaya, L. E.; Zelentsov, S. S.; Saprikova, N. M. pp 10-15 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

Dimethylsulfoxide, widely used as a solvent, is a strong electron donor ligand with a capacity for coordination both with oxygen and sulfur. A series of mixed uranyl complexes with dimethylsulfoxide was obtained with the formulas $UO_2(CH_3COO)_2 \cdot DMSO$, $UO_2C_2O_4 \cdot DMSO$, $(UO_2C_2O_4)_3 \cdot 5DMSO$, $UO_2F_2 \cdot DMSO$, $UO_2SO_4 \cdot 2DMSO$, $UO_2(NO_3)_2 \cdot 2(4)\,DMSO$, and $UO_2Br \cdot 3(4)DMSO$. It was noted that the number of DMSO molecules coordinated with the uranyl during precipitation of the complex in excess DMSO depends on the nature of the acidoligand and correlates with its sequence in the series according to the replacement capacity in the coordination sphere of the uranyl. Some of the complexes obtained were characterized thermogravimetrically. (tr-auth)

3138 STUDY OF URANYL COMPLEXES WITH DIMETHYLSULFOXIDE BY IR AND NMR SPECTROSCOPY. Nikol'skaya, L. E.; Shcherbakova, L. L.; Zelentsov, S. S. pp 16-25 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The ir spectra of a series of mixed uranyl complexes with dimethylsulfoxide were studied in the range from 400 to 4000 cm^{-1}. The data obtained led to conclusions on the mutual effects of the ligand in the coordination sphere of the uranyl. The size of the contribution of DMSO to the decrease of the frequency of the asymmetric valence oscillation in the UO_2^{2+} group was determined by the additive scheme of Vdovenko, Mashirov, and Suglobov. On the basis of the evaluation of the size of this contribution, conclusions were drawn on the structure of some complexes. The study of the NMR spectra of solutions of chloride, nitrate, and perchlorate complexes showed the coexistence in the solution of complexes differing by the type of DMSO coordination and by its lability in the uranyl coordination sphere. (tr-auth)

3139 MIXED PEROXY-OXALATE COMPLEXES OF URANYL ION COMPLEXES. Gurevich, A. M.; Polozhenskaya, L. P.; Kurbatov, V. V.; Osicheva, N. P.; Solntseva, L. F. pp 25-31 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

Some peroxy-oxalate uranyl complexes of the type $Me_{2n-2}[(UO_2)_2(OO)(C_2O_4)_n(H_2O)] \cdot mH_2O$ and $Me_{2n_1}[(UO_2)_2(OO)_2(C_2O_4)_{n_1}(H_2O)x_1] \cdot m_1H_2O$, where n = 2, 3, and 4, and Me = K, Na, and Ba, were synthesized. Their physical-chemical properties were studied. Many of these compounds were synthesized for the first time. A scheme was proposed for complex formation in the $UO_2^{2+} - C_2O_4^{2-} - H_2O_2 - H_2O$ system. It was shown that the formation of peroxy-oxalate uranyl complex compounds procedes in the same pH range x as for the formation of oxalate complexes of the uranyl ion. An evaluation was made of the stability constant of the peroxy-oxalate complexes formed. It was shown that in the internal sphere the peroxy groups are bound with the uranyl ion much more stably than the oxalate groups. (tr-auth)

3140 INTERACTION OF URANYL ACIDOCOMPLEXES WITH TIN TETRACHLORIDE. Vdovenko, V. M.; Kovaleva, T. V.; Kanevskaya, N. A.; Suglobov, D. N. pp 31-35 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The interaction of tin tetrachloride with uranyl acidocomplexes in the form of salts of tetradecylammonia in benzene and carbon tetrachloride was studied. It was established that with excess $SnCl_4$, UO_2F_2 and $UO_2(CH_3COO)_2$ were precipitated in the fluoride and acetate systems. The existence of intermediate compounds with cross-linkage bounds $UO_2^{2+} - L - SnCl_4$ was also established. The trinitrate and triperchlorate uranyl complexes do not interact with $SnCl_4$. (tr-auth)

3141 URANYL HALOGEN ACETATES. Vdovenko, V. M.; Baluev, A. V.; Suglobova, I. G. pp 35-40 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

A description was given of the synthesis of $UO_2(CCl_3COO)_2 \cdot 3H_2O$,

$UO_2(CCl_3COO)_2 \cdot 2H_2O$, $UO_2(CCl_3COO)_2 \cdot H_2O$, $UO_2(CF_3COO)_2 \cdot 1.5H_2O$, $UO_2(CF_3COO)_2 \cdot H_2O$, $UO_2(CF_3COO)_2$, $UO_2(CH_2ClCOO)_2 \cdot H_2O$, and $UO_2(CH_2ClCOO)_2$. The water vapor pressure at which the hydrates of these salts were stable was determined. The ir spectra of these compounds were determined in the frequency region from 600 to 4000 cm^{-1}. Band assignments were made. On the basis of the ir spectra an hypothesis was made on the possible molecular structure of the uranyl halogenide acetates. (tr-auth)

3142 Np(IV) ETHYLENEDIAMINETETRAACETATES. Mefod'eva, M. P.; Gel'man, A. D.; Krot, N. N. pp 40-44 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

Np(IV), similarly to U(IV), can form under given conditions complexes with EDTA with a composition 2:1, 1:1, and 2:3. The crystalline compounds $NpY \cdot nH_2O$, $Ba_2Np_2Y_3 \cdot nH_2O$, and $(NH_4)_2 H_2Np_2Y_3 \cdot nH_2O$ were synthesized and some of their properties were determined. The size of K_n was made more precise for NpY. (tr-auth)

3143 COMPLEX FORMATION OF Pu(III) WITH AMINO ACIDS. Rogozina, E. M.; Konkina, L. F.; Pipov, D. K. pp 44-49 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The complex formation of Pu(III) with tryptophan, histidine, phenylalanine, tyrosine, and arginine in aqueous solutions was studied by the methods of ion exchange and dialysis. For calculation of the instability constant, the method of relative absorption curves was used. It was established that all amino acids form with Pu(III) fairly stable complex compounds. During comparison of the complex-forming capacity of amino acids with Pu(III) it was concluded that tryptophan and histidine form more stable compounds (pK = 4.2 and 4.5) than phenylalanine and tyrosine (pK = 3.8 and 3.3). The difference in the behavior of these amino acids in aqueous solution was explained by the presence of different ring structures in their composition. The benzene ring of phenylalanine and tyrosine do not participate in the complex formation. The comparatively low stability of Pu-arginine complexes (pK = 3.5) was explained by the presence of a second amino group which increases the basisity of the amino acid and therefore somewhat reduces its complex-forming capacity. (tr-auth)

3144 SOME REGULARITIES DURING THE COMPLEX FORMATION OF Am(III), Cm(III), AND Pm(III) WITH PHOSPHORUS- AND CARBOXYL-CONTAINING LIGANDS. Elesin, A. A.; Zaitsev, A. A. pp 49-54 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

Regularities during the complex formation of Am(III), Cm(III), and Pm(III) with some phosphorus- and carboxyl-containing ligands were examined. The correlation dependences were established and explanations were given for the deviations observed. (tr-auth)

3145 ELECTROMIGRATION METHOD FOR THE STUDY OF THE KINETICS OF THE COMPLEX FORMATION OF Eu(III), Am(III), AND Cm(III) WITH 1,2-DIAMINECYCLOHEXANETETRAACETIC ACID. Stepanov, A. V. pp 55-60 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The rate constants for the reactions of formation and dissociation of complexes of Am(III), Eu(III), and Cm(III) with DCTA were studied in the pH range from 2.3 to 2.9 at $\mu = 0.1$ (KNO_3 medium) using the electromigration method in non-equilibrium conditions. The rate of the direct reaction obeyed a second order equation with the values $k_{01} = (3.6 \pm 0.3) \times 10^7$, $(3.6 \pm 0.3) \times 10^7$, and $(3.0 \pm 0.3) \times 10^7$ l/mol·sec for Am, Eu, and Cm at 25°C. The dissociation reactions also obeyed a second order kinetic equation. The values of k_{02} at 25°C were equal to 4.4 ± 0.3, 3.2 ± 0.3, and 2.6 ± 0.2 l/mol·sec for Am, Eu, and Cm. From the temperature dependence of k_{01} and k_{02} the activation parameters were determined for the direct and reverse reactions. (tr-auth)

3146 COMPLEX FORMATION OF ACTINIUM AND DETERMINATION OF ^{227}Ac FROM ^{223}Fr BY THE ELECTROMIGRATION METHOD. Makarova, T. P.; Sinitsyna, G. S.; Stepanov, A. V.; Gritchenko, Z. G.; Shestakova, I. A.; Shestakov, B. I. pp 60-66 of Kompleksoobrazovanie i Ekstraktsiya Aktinoibov i Lantanoidov. Vdovenko, V. M. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1974). (In Russian).

The composition and stability constants of complexes of Ac with EDTA, 1,2-DCTA, and oxalic and citric acids were determined by electromigration on a quartz filler. A comparison was made of the values obtained with the corresponding stability constants of complexes of La, Y, and other rare earths. The optimum conditions for the separation of Ac and La in some solutions were determined. The results of the separation of La and Ac by electrophoresis on Whatman-31 paper were reported. A paper electrophoresis method for the rapid separation of the decay products of ^{227}Ac and determination of Ac from Fr concentration was proposed. (tr-auth)

3147 AUGER ELECTRON AND CHARACTERISTIC ENERGY LOSS SPECTRA OF PLUTONIUM. Larson, D. T.; Adams, R. O. (Dow Chemical U. S. A., Golden, Colo. Rocky Flats Div.). Surface Sci.; 47: No. 2, 413-421(Feb 1975).

The Auger electron and characteristic loss spectra of plutonium were obtained for the first time using a four grid retarding potential analyzer. The surface of this reactive metal was prepared by scribing in situ in good vacuum with a titanium carbide blade. Oxygen and carbon impurities were still present after scribing. The origin of the Auger electron and loss peaks is suggested, and a correlation is made with the peaks observed for uranium dioxide by Ellis and Campbell. (auth)

Radioactive Waste Treatment

Refer also to abstracts 3162 and 5312.

3148 (BNL-19650) DEVELOPMENT OF DURABLE LONG-TERM RADIOACTIVE WASTE COMPOSITE MATERIALS. Progress Report No. 9, October–December 1974. Colombo, P.; Steinberg, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y. (USA)). Jan 1975. 34p. Dep. NTIS $4.75.

The three preliminary composite formulations being considered are: lumnite–zeolite concrete; lumnite–zeolite–$[Fe(OH)_3–MnO_2]$; and lumnite–bentonite–$[Fe(OH_3)–MnO_2]$. Flow schemes, fixation costs, volume reduction, and leachability are discussed. (LK)

3149 (KFK-2119) BITUMINIZATION OF RADIOACTIVE WASTES AT THE NUCLEAR RESEARCH CENTER KARLSRUHE. Baehr, W.; Hild, W.; Kluger, W. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Oct 1974. 24p. (CONF-741017-32). Dep. NTIS (US Sales Only) $4.25.

From meeting of the American Nuclear Society; Washington, District of Columbia, USA (27 Oct 1974).

At the Karlsruhe Nuclear Research Center operation of the industrial bituminization plant for evaporator concentrates from low- and intermediate level radioactive effluents is flanked by R&D activities aiming both at the definition of operation conditions for the bituminization of other types of radwaste and at the investigation of related safety aspects. The essential part of the continuously operated industrial bituminization plant is a self-cleaning screw-extruder-evaporator. A 200°C steam heating allows the operation of the apparatus at a flexible temperature profile. Evaporation capacity is 140 kg H_2O/hr at very low residence times and low material hold-up. The apparatus is at the same time homogeneously mixing and coating the radioactive salt residues and efficiently evaporating the water contained in the evaporator concentrates. After two years more than 1000 drums were filled with bitumen products, containing some 10^4 Ci fission products from more than 25000 m^3 low- and intermediate level radioactive effluents. A bench-scale screw extruder unit of roughly 4 kg/hr evaporation capacity is operated at the R&D level. This unit guarantees the production of bitumen-products of exactly the same characteristics as those produced in the bituminization plant. This condition is essential for the performance of realistic investigations on bituminization and characterization of the resulting products. Apart from the determination of optimum operation conditions for concentrates containing chemically and thermally unstable compounds, incorporation conditions for power reactor wastes have recently been established. At the same time investigations on the product characteristics (leaching, DTA-TGA, fire and explosion-hazard, fire fighting, etc.) are performed. Both plant and R&D experience demonstrate that bituminization is a safe and effective means for the solidification of low- and intermediate level radwaste. (auth)

3150 (ORNL-TM-4701) ENGINEERING EVALUATION OF THE IODOX PROCESS. Part 2. Removal of Iodine From Air Using a Nitric Acid Scrub in a Bubble-Cap Column. Part 3. Correlation of Mass-Transfer Data. Part 4. Process Sensitivity to Impurities. Groenier, W. S.; Hannaford, B. A. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 74p. AT.

A study was made of the removal of iodine or iodomethane from an air stream using hyperazeotropic (~20 M) nitric acid at room temperature; a 3-in.-diam bubble-cap column was used to extend the development of the Iodox process to a more practical

gas-liquid contactor. Decontamination factors (DFs) averaged about three to four per plate to produce overall column DF values as high as 3×10^4 for seven plates operating at a nominal air flow of 1 scfm. Experimental mass-transfer data from these and previous experiments (packed column studies) were correlated using the classical two-film diffusional model that resulted in the calculation of engineering design parameters useful for scale-up and design studies. Basic laboratory data necessary to this correlation are summarized. The overall mass-transfer coefficient was found to be a function of the absorption coefficient. Treatment of a 100-cfm off-gas stream to obtain a DF of 10^5 could theoretically be accomplished using a 20-in.-diam bubble-cap column having ten plates. Hexane, benzene, and iodobenzene were selected as typical nuclear fuel reprocessing plant off-gas organic impurities and were admitted to the Iodox process (packed-column system) to measure any deleterious effects on iodine removal efficiency. The aromatic contaminants in the air appeared to have little effect on iodine removal, whereas the aliphatic contaminant measurably reduced column performance. However, the use of a condenser having a large surface area and volume to allow an increased gas and condensate residence time increased system performance in these high temperature (60 to 100°C), < 20 M HNO_3 runs to the level where the presence of hexane was no longer undesirable. The use of recycled nitric acid resulted in no change in iodine removal efficiencies, despite appreciable concentrations of dissolved iodine species. Bubble-cap columns are preferred for future Iodox process installations. An integrated system that produces 22 M HNO_3, scrubs simulated off-gases, and collects iodine as anhydroiodic (HI_3O_8) acid is being fabricated. (auth)

3151 (ORNL-TM-4883) REMOVAL OF RADON-220 FROM HTGR FUEL REPROCESSING AND REFABRICATION OFF-GAS STREAMS BY ADSORPTION (BASED ON A LITERATURE SURVEY). Ackley, R. D. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 30p. Dep. NTIS $4.00.

Literature theory and data considered relevant to the removal of Rn-220 from HTGR fuel reprocessing and refabrication off-gas streams by adsorption are presented. The data include equilibrium adsorption coefficients for radon on activated carbon (charcoal) and silica gel in the presence of air and other gases, and for radon on molecular sieve Type 5A in the presence of air. Also included are a few dynamic adsorption data (adsorption coefficients and values for the number of theoretical plates per foot) for radon on charcoal, with air as the carrier gas. These various data, which were obtained mainly at or near 25°C, are actually for Rn-222; however, they should also be applicable to Rn-220, provided the conditions are the same. Based on the available information, the radon adsorption coefficients decrease in the expected order: charcoal, molecular sieve Type 5A, and silica gel. Thus, charcoal should be the most effective of these adsorbents for Rn-220 removal; however, its use for this application cannot be recommended until the associated fire and explosion hazards, particularly those with regard to interaction with ozone, are resolved. Sorbent poisoning and particle penetration due to alpha-recoil are briefly treated. Adsorber design is discussed. Existing information appears adequate for sizing, albeit crudely, the sorbent bed for a Rn-220-charcoal-air (1-atm, less than 10 percent relative humidity) system, and a suggested approach for doing this is outlined. (auth)

3152 (Y-1179) RETENTION OF URANIUM HEXAFLUORIDE FROM A GAS STREAM OF HYDROGEN FLUORIDE. Dietrich, W. C.; Rowan, J. H.; Schreyer, J. M. (Oak Ridge Y-12 Plant, Tenn. (USA)). 30 Jul 1957. Contract W-7405-eng-26. 20p. Dep. NTIS $4.00.

Declassified 23 Apr 1975.

Calcium sulfate was investigated in order to quantitate its use as a trapping medium for the retention of uranium hexafluoride present in a plant off-gas consisting essentially of gaseous hydrogen fluoride. This material was found to have a capacity and retention power for UF_6 which was dependent upon the water of hydration present. Under the conditions of elevated temperature and excess H_2F_2 sweep, the retention of UF_6 was considered poor. Sodium fluoride, lithium fluoride, calcium fluoride, potassium dihydrogen phosphate, sodium nitrate, and perfluorotributylamine were tested and found to be unsuitable substitutes. Electrostatic precipitation of the complex formed by the gaseous interaction of UF_6 and water vapor was studied briefly. (auth)

3153 FIXATION OF RADIOACTIVE STRONTIUM USING HYDROXIDES OF DIFFERENT METALS. Ghattas, N. K. (Atomic Energy Commission, Cairo). J. Radioanal. Chem.; 24: No. 2, 327-336(1975).

Carrier-free radioactive ^{89}Sr was used to study the adsorption capacities of hydroxides of the metals iron, titanium and manganese at different pH values and at different standing times. The results show that more than 95% of the strontium activity is removed from its solution if the pH is higher than 6.5 for both iron and titanium hydroxides, and higher than 7.8 for manganese hydroxide, when the standing time is higher than 1000 m. In the case of the use of a strontium carrier ($1 \cdot 10^{-3}$ mole/l) it was shown that all the metal hydroxides have the same fixation efficiency for strontium at high pH. Only 300 mg of the metal oxides per liter was enough to remove more than 95% of the strontium activity from its solution. (auth)

Radioisotope Production

Refer also to abstract 3011.

3154 LARGE-SCALE PRODUCTION OF CARRIER-FREE ^{206}Bi FOR MEDICAL APPLICATION. Brown, L. C.; Callahan, A. P. (Oak Ridge National Lab., TN). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 213-217(Apr 1975).

An enriched ^{207}Pb cyclotron target design was developed for the large-scale proton production of ^{206}Bi (~185 mCi/hr) with < 2% ^{205}Bi contamination. Simple and efficient chemical procedures have also been developed and tested for the separation and purification of carrier-free ^{206}Bi suitable for human use and for the recovery of the enriched ^{207}Pb target material to allow economical operation. (auth)

3155 PREPARATION OF CARRIER-FREE RADIOACTIVE ^{27}Mg. Alfassi, Z.; Kushelevsky, A. P. (Univ. of Negev, Beer Sheva, Israel). Radiochem. Radioanal. Lett.; 21: No. 1-2, 87-89 (14 Apr 1975).

A simple method to produce and separate carrier-free ^{27}Mg by irradiating Al_2O_3 powder with 14-MeV neutrons and eluting the ^{27}Mg produced by the $^{27}Al(n,p)^{27}Mg$ reaction with hot acid is described. (auth)

3156 SEPARATION OF NUCLEAR REACTION PRODUCTS IN THE GAS PHASE. II. Separation of Ru with Oxygen. Boegl, W.; Baechmann, K. (Technische Univ., Dormstadt, Ger.). J. Inorg. Nucl. Chem.; 37: No. 5, 1115-1119(May 1975).

The separation of Ru-nuclides in the gas phase has been investigated. The Ru-nuclides were produced by a Cf-252 source. A detailed study of the behavior of Ru-nuclides which form volatile compounds with oxygen has been carried out. The separation yields of Ru are given as a function of the oxygen concentration, the temperature of the cooling trap and the temperature of the transportation tube. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 3472.

3157 (BARC/I-253) PILOT PLANT STUDIES WITH MIXER SETTLERS. Balasubramanian, G. R.; Srinivasan, N. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 10p. INIS.

A mixer-settler of three stages was used as solvent extraction contactor in the Thorex pilot plant in view of the compact layout it can offer to suit the available space. Pump mixer-settlers were chosen among the many other existing types due to the self-regulation of interface they offer. The K. A. P. L. design was tried in the studies. The main aspects studied include: utilization of an air life arrangement for organic feed and employment of a jackpot for regulation of the interface instead of the conventional diaphragm control valve. It has been concluded that (i) while better conditions of hydraulic stability of operation are established for mechanically agitated mixer-settlers, there is a good possibility of substituting air pulsing and (ii) smooth operation of pressure pot instead of diaphragm control valve for control of interface is a definite feature of improvement over the earlier model. (INIS)

3158 (CONF-731218-P1, pp 175-184) IODINE RETENTION IN REPROCESSING PLANTS. Herre, F. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH, Leopoldshafen, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

A description is given of the idodine filtering equipment at the reprocessing plant at Karlsruhe (WAK), together with details of preliminary test results and operating experience in the two years to date. The problems of iodine retention in large-scale plants are listed. (auth)

3159 (CONF-731218-P1, pp 185-198) IODINE TRAPPING FROM THE EXHAUST AIR OF REPROCESSING PLANTS. Furrer, J.; Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Reprocessing plants are at present being planned for a fuel throughput of 1500 t/a. Assuming that the fuel comes from light water reactors, is discharged after 2 years of full power operation and reprocessed after a cooling period of 160 days, a total decontamination factor of 1800 must be achieved to prevent emission in excess of 0.1 mCi/h I-131 through the exhaust stack of the reprocessing plant. In addition, approx. 280 kg I-129 with a total activity of 46 Ci I-129 are produced during one year's operation. It would seem advisable to bind, immediately at the beginning of reprocessing, the I-129 ($T_{\frac{1}{2}}$ 1.7×10^7 y) to solid sorption materials, which can be permanently stored. This would eliminate all problems presented by the occurrence of I-129 in the waste solutions from the reprocessing plant. The retention behavior of iodine sorption material in laboratory tests with air-NO_2 mixtures as carrier gas is described. In addition the efficiency of the material in the tank and solvent exhaust gases of a reprocessing plant is discussed. (auth)

3160 (GA-A-13279) REPROCESSING DEVELOPMENT FOR HTGR FUELS. Heath, C. A.; Spaeth, M. E. (General Atomic Co., San Diego, Calif. (USA)). 15 Feb 1975. Contract AT(04-3)-167. 38p. (CONF-750424-2). Dep. NTIS $5.00.

From American Nuclear Society meeting on commercial nuclear fuel technology today; Toronto, Ontario, Canada (27 Apr 1975).

The technology required for the recycle of the bred ^{233}U in the HTGR fuel requires reprocessing to extract the valuable fissile materials in the spent fuel from the fission product wastes and refabrication. The development program being undertaken for reprocessing of HTGR fuels is described. Reprocessing flowsheet, process requirements, size reduction, fluidized-bed burning, dissolution, solvent extraction, and waste disposal are considered. (JSR)

3161 (GERHTR-124) CRITERIA FOR HTR-FUEL REPROCESSING PLANT SITE EVALUATION. Riedel, H. J.; Laser, M.; Merz, E.; Schnez, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Chemische Technologie). 1974. 21p. (SM-188/20). Dep. NTIS (US Sales Only) $4.25.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

The siting of nuclear facilities in densely populated areas will become more and more difficult. Several criteria were established for the evaluation of nuclear facility sites. In the USA the advance in reactor technology has made it possible to establish site independent criteria for reactor design, characterized by the limitation of radioactive effluents independent on the real impact to the population. For reprocessing plants presently no site independent criteria exist. But it must be taken into account that these plants must be designed in such a manner that in nearly all important regions a suitable site can be found. A completely site independent design for HTR-reprocessing plants will be impossible with the present technology to comply with a whole-body burden of 30 mrem/a at the most unfavorable location offsite the plant as recommended by the German Atomic Energy Commission, but it will be shown that it is possible to select sites at which this limit will not be exceeded. For site evaluation for an HTR-reprocessing plant the most important siting criterias are divided into three groups. The first consists of general criteria which influence the design of the facility or which can determine the final site in the selected region. The second group comprises the more important criteria which may be site determining because they cannot be influenced by reasonable means. Economic considerations dealt with in the third group are likewise important for several items described in the preceding two groups. Considering the different weight of the criteria, four typical areas in the German Federal Republic are taken into consideration for siting of an HTR-reprocessing plant. (auth)

3162 (ICP-1063) IDAHO CHEMICAL PROGRAMS ANNUAL TECHNICAL REPORT, FISCAL YEAR 1974. Bower, J. R. (ed.). (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs – Operations Office). Jan 1975. Contract AT(10-1)-1375. 181p. Dep. NTIS $7.60.

The operating experience in fuel processing, waste calcining, and other waste management activities at the ICPP for FY 1974 is summarized. A new zirconium fuel dissolver has performed well, and the first-cycle extraction system shows near-zero losses. Approximately 390,000 gallons of high-level wastes were calcined during the period. Technical support activities in the areas of current and proposed operations at the ICPP are also presented. These include: a flowsheet to reduce acid consumption and volume of liquid wastes in the electrolytic process; a new dissolution process for ternary oxide PWR fuel using zirconium-fluoride-nitric acid dissolvent; a study and recommendation for treatment of fuel storage basin water; progress in design and development of processes for Rover and HTGR fuels, including successful pilot-plant demonstration of burning, fissile- and fertile-particle separation, and particle crushing for the HTGR fuel; corrosion evaluation of bins containing calcined wastes showing corrosion rates indicative of a safe 500-year or greater storage life; demonstration on a pilot-plant scale of conditions for calcination of stainless steel and Rover fuel wastes as well as commercial wastes; evaluation of equipment alternatives for a new waste calcining facility; studies related to improvements in rare gas recovery and process off-gas treatment; demonstration of stability, or lack of it, when various high-level waste solutions are mixed; a detailed discussion of progress on postcalcination treatment of calcined waste solids (ceramic formation, incorporation in metals, and calcine-concretes); studies on removal of actinides from ICPP wastes; a conceptual design for a proposed radioactive solid-waste repackaging facility for the INEL. Significant progress is reported on the program for determination of burnup for fast breeder reactor fuels; fast fission yield measurements are reported for ^{233}U, ^{235}U, and ^{238}U, and initial development of a system for correlation of fission yields with neutron energy is reported. (auth)

3163 ELECTROLYTIC METHODS FOR APPLICATION IN THE PUREX PROCESS. Schmieder, H.; Baumgaertner, F.; Goldacker, H.; Hausberger, H.; Warnecke, E. (Gesellschaft fuer Kernforschung, Ger.). pp 1997-2018 of Solvent Extraction. London; Society of Chemical Industry (1974).

From international solvent extraction conference; Lyon, France (8 Sep 1974).

Fundamental investigations in the kinetics of the electrolyses in the system uranium–plutonium–nitric acid–hydrazine and corrosion tests with various electrode materials led to the development of "in situ" electrolytic extraction equipment without a diaphragm. The behavior of Pu, Np, and U in a 16-stage electrolytic mixer-settler is discussed. The mixer-settler was made of titanium (throughput 2 kg/d) and successfully operated as 1B (Pu/U-separation) and 2B (reductive plutonium reextraction) batteries. With an electrolytic pulsed column, similar electrolytic mass-transfer could be achieved. Experiments with a "fissium" mixture show, that deleterious effects caused by fission products, are not to be expected. The development of an electrolytic cell for the oxidation of plutonium between the Purex cycles was started. Extremely high current efficiencies were achieved in a cell, which works without a diaphragm. (auth)

3164 GAS-CHROMATOGRAPHIC CONTROL OF THE EXTRACTANT DURING REPROCESSING OF HTR FUEL. Brodda, B. G.; Merz, E. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Chemische Technologie). Z. Anal. Chem.; 273: No. 2, 113-116(Jan 1975). (In German).

During reprocessing of HTR fuel elements by the THOREX solvent extraction process the tributylphosphate–n-alkane mixture used as extractant is subject to an intensive radiolytic and hydrolytic burden. Main degradation products are di- and monobutylphosphate which in quite low concentrations disturb the solvent extraction by retention of uranium and transfer of some fission products into the aqueous product solution. Both esters are removed from the irradiated solvent by washing with a sodium carbonate solution, after which the solvent may be recycled. For a control of the efficiency of this solvent recovery procedure as well as of the composition of the fresh and recycled solvent in the JUPITER reprocessing facility, gas chromatography will be used. This method allows the determination of di- and monobutylphosphate down to concentration levels of about 25 parts per million. An analysis requires about 100 min. (auth)

CONTROLLED THERMONUCLEAR RESEARCH

3165 PLASMA PHYSICS INDEX. Volume 10, No. 3, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 138p.

3166 PLASMA PHYSICS INDEX. Volume 10, No. 2, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 161p.

3167 PLASMA PHYSICS INDEX. Thesaurus, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 22p.

3168 PLASMA PHYSICS INDEX. Volume 10, No. 1, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 153p.

Plasma Confinement and Heating

Refer also to abstract 3220.

3169 (IAEA-CN-33/C2-3) PLASMA HEATING WITH A ROTATING RELATIVISTIC ELECTRON BEAM. Molvig, K.; Rostoker, N.; Dothan, F. (California Univ., Irvine (USA)). 1974. Contract AT(04-3)34. 10p. (CONF-741105-56). Dep. NTIS $4.00.

From 5th conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

Previously studied processes by means of which energy is transferred from an intense relativistic electron beam to a plasma involve instabilities associated with the primary energetic electrons and indirect coupling of the plasma return current. For return current coupling, a simple treatment was developed based on diffusion equations so that boundary conditions, pulse shape, etc., can be accounted for. This treatment has been applied to a rotating beam produced, for example, by passing an annular beam through a magnetic cusp. The result is that an electric field is set up within the plasma by the Hall effect. The magnitude of this electric field is E/sub r/ equals 300 (n/sub b//n/sub p/)B/sub z/ where n/sub b/ is beam density, n/sub p/ is plasma density; E/sub r/(k-volts/cm) and B/sub z/(k-gauss) are the electric and magnetic fields. The guiding center drift of electrons at velocity v_0 equals cE/sub r//B/sub z/ accounts for the plasma return current. Ions for which the magnetic field can be neglected would be accelerated in the E/sub r/-field to multi-kilovolt energy. The stopping power of the beam is greatly enhanced compared to a non-rotating beam, and the energy is transferred almost entirely to ions. The coupling does not involve instabilities. (auth)

3170 (IC-73-121) ROLE OF NONLINEAR EFFECTS IN THE PROBLEM OF DENSE PLASMA HEATING BY RELATIVISTIC ELECTRON BEAM. Martin, J. P. (International Centre for Theoretical Physics, Trieste (Italy)). Sep 1974. 15p. INIS.

Information is given on theoretical investigations in the USSR devoted to various nonlinear effects accompanying the interaction of an intense relativistic beam with a dense plasma target. When considering the beam slowing down, nonlinear effects may be essential in the definition of the effective free path length with respect to the transformation of energy from the electrons to the plasma noises, as well as in the subsequent dissipation of the oscillations. The first part of the paper is concerned with the stabilization of beam-plasma instability. In the second part, some results of the strong turbulence investigation are given. (INIS)

3171 (UCI-34P207X2) STUDY OF PLASMA HEATING BY INTENSE RELATIVISTIC ELECTRON BEAMS. Progress Report, 31 January 1974–31 October 1974. Rostoker, N.; Rynn, N. (California Univ., Irvine (USA)). Oct 1974. Contract AT(04-3)-34. 65p. Dep. NTIS $6.25.

An experiment to investigate plasma heating resulting from the interaction of an intense rotating relativistic electron beam is described. Calculations show that a radial electric field is set up within the plasma by the Hall effect. The magnitude of this electric field is E/sub r/ equals 300 (n/sub b//n/sub p/)B/sub z/ where n/sub b/ is the beam density, n/sub p/ the plasma density; E/sub r/(K - volts/cm) and B/sub z/(K-gauss) are the electric and magnetic fields. Ions for which the magnetic field can be neglected would be accelerated in the E/sub r/–field resulting in ion temperatures of the order of a kilovolt for the experiment. Theoretical investigations of the stability of the rotating beam plasma configuration show that it is unstable. However, the growth is proportional to one over the cube root of the conductivity and results in an axial modulation of the beam which should not be disruptive. Construction and testing of the plasma gun was completed. The plasma gun produces a plasma which fills the 20 cm diameter chamber. The density was measured with a 2 mm microwave interferometer and found to be greater than 10^{14} particles/cm^3. The plasma velocity is of order 10 cm/mu s. This results in a highly ionized plasma since the slow neutrals remain behind. It is also found that the plasma has sufficient velocity to go through the cusp and provide charge neutralization in the diode-cusp region. (auth)

3172 (UCRL-75881) RAY TRACE LASER SOURCES IN LASNEX. Bailey, D. S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 16p. (CONF-741079-6). Dep. NTIS $4.00.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

In order to treat real laser sources propagating in real target plasmas without solving Maxwell's equations, a geometric optics approximation was used to obtain the energy flow and deposition. The scheme used and two examples are described. The first is a slab of CH_2 illuminated with a 2 nsec, 10 J 40 mu radius spot of a CO_2 laser of uniform intensity profile up to the sharp drop at the spot radius. The second example was designed to see the effect of illumination on a low compression (approximately 10) experiment. (MOW)

3173 (UCRL-75882) LASER–PLASMA CALCULATIONS WITH REFRACTION. Pan, Y. L.; Shay, H. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 15p. (CONF-741079-12). Dep. NTIS $4.00.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

Computer calculations of light propagation in a medium with a quadratic density gradient transverse to the direction of propagation are presented. Test results for positive and negative values of the sinusoidal oscillation are described. Another problem considered was the propagation of light rays inside a spherical plasma with a density profile which increases with r. (MOW)

3174 (UCRL-75883) HEATING AND CONDUCTION IN LASER-PRODUCED PLASMAS. Shay, H. D.; Zimmerman, G. B.; Nuckolls, J. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 20p. (CONF-741079-13). Dep. NTIS $4.00.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

A series of experiments conducted by G. McCall of LASL provides important clues concerning the electron distributions heated in the absorption of intense (less than or approximately equal to 10/sup 1b/ W/cm^2) laser radiation and the thermal transport of energy. Presented here is a tentative interpretation of these experiments obtained from LASNEX calculations. (auth)

3175 (UCRL-75884) NON-MAXWELLIAN ION DISTRIBUTIONS IN COMPRESSED LASER TARGETS. Zimmerman, G. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 22p. (CONF-741079-14). Dep. NTIS $4.25.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

The validity of the Maxwellian assumption when used to calculate neutron yields from thermonuclear DT fuel compressed and heated by laser irradiation is analyzed. Detailed Fokker–Planck calculations show that this approximation is adequate in cases of interest. (auth)

3176 SIMULATION OF LASER BEAT HEATING OF A PLASMA. Cohen, B.I.; Mostrom, M.A.; Nicholson, D.R.; Kaufman, A.N.; Max, C.E. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Langdon, A.B. Phys. Fluids 18: No. 4, 470-474 (Apr 1975).

A new relativistic electromagnetic computer simulation code, with one spatial dimension, is described which explicitly follows right- and left-going electromagnetic waves by integrating along the characteristics of Maxwell's equations. To illustrate its suitability for the study of laser-plasma interactions, simulations are discussed of the heating of plasma by two opposed lasers whose beat frequency drives a local plasma

oscillation. Excellent agreement is obtained with analytic theory in the linear-response regime. (auth)

3177 COMMENTS ON "FIELD GENERATING THERMAL INSTABILITY IN LASER-HEATED PLASMAS". Manheimer, W.M. (Naval Research Laboratory, Washington, D.C. 20375); Tidman, D.A. Phys. Fluids 18: No. 4, 496-496 (Apr 1975).

There is an additional solution to the zero-order heat flux equations which gives no instability in laser produced plasmas. (AIP)

3178 PENETRATION OF SLOW WAVES INTO A DENSE PLASMA USING A PHASED WAVE-GUIDE ARRAY. Bernabei, S.; Heald, M.A.; Hooke, W.M.; Paoloni, F.J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Rev. Lett. 34: No. 14, 866-870 (7 Apr 1975).

We report experimental evidence of wave coupling and penetration to the interior of a high-density magnetoplasma using a double-wave-guide antenna as a slow-wave structure. Reflection coefficients as low as 4% were observed. The experiment used 9-cm microwaves with a plasma of 11-cm diam. The relevance to lower-hybrid heating of tokamak fusion plasmas is discussed. (auth)

3179 FILAMENTATION AND SUBSEQUENT DECAY OF LASER LIGHT IN PLASMAS. Langdon, A.B.; Lasinski, B.F. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. Lett. 34: No. 15, 934-937 (14 Apr 1975).

It has been predicted that an intense light beam in a plasma will break up into a number of self-focused filaments. We show that as a result of filamentation, strong plasma heating can occur in a wider range of densities than has been expected. The laser light decays into lower frequency modes which then heat the electrons and assist in the further development of a narrow filament. (auth)

3180 ION HEATING BY THE LOWER HYBRID MODE. Krishan, S.; Ravindra, M.P. (Division of Physics and Mathematical Sciences, Indian Institute of Science, Bangalore 560012, India). Phys. Rev. Lett. 34: No. 15, 938-940 (14 Apr 1975).

The lower hybrid mode excited in a plasma with cross-field current and density gradient induces an attractive potential between the negative- and positive-energy modes of the plasma. The growth rate is thereby reduced and becomes comparable with the damping rates due to wave-particle interaction. This leads to the saturation of the turbulent field. Some applications have been made to the turbulent heating experiments in plasmas where cross-field current is present. (auth)

3181 INTENSITY VARIATION OF REFLECTED ENERGY FROM SPHERICAL GLASS SHELL LASER FUSION TARGETS. Downward, J.G. (KMS Fusion, Incorporated, Ann Arbor, Michigan 48106). J. Appl. Phys. 46: No. 5, 2147-2152 (May 1975).

The fraction of the energy reflected by spherical glass shell targets irradiated with 1.06-μm laser pulses is measured for average intensities up to 4×10^{15} W/cm^2. The on-target energies ranged up to 230 J with laser pulse half-widths of from 0.03 to 1.0 nsec. The glass shells ranged in diameter from 57 to 553 μm. Using the KMS Fusion two-channel disk laser system, the shells were illuminated at 1.06 μm from opposite sides at near-normal incidence. Two illumination systems were investigated. In the first, the target was illuminated with a pair of *f*/0.6 lenses providing approximately 80° per side (full cone angle) of near-normal incidence. In the second, the *f*/0.6 lenses were used in conjunction with an ellipsoidal mirror system which provides 144° per side (full cone angle) of normal illumination to within 18°. The fraction of the energy reflected from the targets was found to vary as a power of the average intensity on target over the range 4×10^{13} to 4×10^{15} W/cm^2. Within this range no sudden onset of enhanced energy absorption or reflection by the targets was observed. Measurements were also made of the 1.06-μm radiation scattered from the target at 45° and 90° to the laser axis. The scattering was roughly isotropic. The light reflected from the targets was found to be approximately 20% depolarized. (auth)

3182 PLASMA HEATING AND NEUTRON GENERATION DURING SPHERICAL IRRADIATION OF A TARGET WITH POWERFUL LASER RADIATION. Basov, N. G.; Krokhin, O. N.; Sklizkov, G. V.; Fedotov, S. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 76: 146-185(1974). (In Russian).

A description is presented of a powerful laser unit with a parallel system of amplifiers for high-temperature heating of a plasma. Experimental studies were carried out of the basic parameters of the radiation at the exit of the unit, and the coherent properties and spectral composition of the radiation were investigated. The radiation energy is 400 to 1300 joules at a light pulse duration of 1 to 16 nseconds; the contrast quality is $\sim10^7$; the brightness is $\sim10^{17}$ watts/cm^2 stere. An analysis is carried out of the requirements placed on the parameters by laser systems intended for the high-temperature heating of a plasma during spherical irradiation of a target and realizing a thermonuclear reaction. Experimental studies were carried out of processes taking place during the high-temperature heating of a plasma in the spherical irradiation geometry of an insulated solid target with radiation from ten laser beams. Experimental studies of plasma x radiation were conducted. It was found that in this region of the spectrum, up to 20% of the laser emission energy absorbed by the plasma is converted to radiation. The neutron yield from a $(CD)_n$-plasma is $\sim10^7$ neutrons per pulse. It is shown that neutron generation in a laser plasma has a thermal character. The gasdynamic expansion of the plasma was investigated. The pressure on the target surface as a result of "ablation" attains a value of $\sim2\times10^8$ bar. It is shown that at these pressures there exists strong compression of the plasma nucleus to a value of ~40. (32 figures, 40 references) (tr-SJR)

3183 INJECTION AND DRIFT STUDIES OF HIGH CURRENT RELATIVISTIC ELECTRON BEAMS IN A TOROIDAL-LIKE SYSTEM. Gilad, P.; Kusse, B.R.; Lockner, T.R. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). Phys. Fluids 18: No. 5, 607-613 (May 1975).

The successful use of an external field shaping cathode to inject high current relativistic *E* beams (500 kV, 20 kA, 50 nsec) across a toroidal magnetic field (1–4 kG) into a metallic vessel is presented. Injection of up to 50% of the diode energy into trajectories far removed from the metal wall ($>5r_L$) was achieved. Drift properties if the *E* beam in the toroidal vessel were studied. Energy fluence down the torus was measured. Up to 60% of the injected beam was recovered after propagating a distance of 8 m. The drift time around the torus was found to be long enough to enable trapping the beam in the toroidal system. (auth)

3184 DECAY INSTABILITY OF LOWER HYBRID WAVES. Ott, E. (Department of Electrical Engineering and Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14850). Phys. Fluids 18: No. 5, 566-569 (May 1975).

The parametric decay of an incident lower hybrid pump wave to two lower frequency lower hybrid waves only occurs for a finite wavelength (nondipole) pump wave and can be an important process in lower hybrid resonance heating schemes. The growth rates and thresholds of this instability in homogeneous and inhomogeneous plasmas are obtained and discussed. (auth)

3185 LASER HEATING OF A PLASMA IN A SOLENOIDAL MAGNETIC FIELD. Steinhauer, L.C.; Ahlstrom, H.G. (Mathematical Sciences Northwest, Inc., Bellevue, Washington 98009). Phys. Fluids 18: No. 5, 541-546 (May 1975).

A model representing the laser heating of a plasma in a straight solenoid magnetic field has been analyzed. The model incorporates an idealized plasma cross section, but otherwise appears to very accurately represent the real problem. The difficulty of unequal electron and ion temperatures is averted by considering only the equilibrium limit. The frozen ion limit is examined briefly and found to differ from this only by factors generally near one. The complicated exact solution of the model is approximated to good accuracy by simple expressions. (auth)

3186 PLASMA EQUILIBRIUM AND CONFINEMENT IN A POLOIDAL HELIOTRON CONFIGURATION. I. Zykov, V. G.; Karpukhin, V.I.; Lonin, Yu.F.; Podteregera, N.N.; Rudnev, N.I.; Tolok, V.T. Sov. Phys.—Tech. Phys. 19: No. 8, 1063-1068 (Feb 1975).

The equilibrium and confinement of an injected plasma [$n\sim10^{12}$ cm^{-3}, $T_e\sim10$ eV, $T_i\sim5$–50 eV] have been studied in a toroidal trap with a poloidal heliotron field. The plasma reaches a stable equilibrium in the heliotron field with decay governed by the charged-particle loss at the supports of the opposed-field coils which produce the heliotron configuration. (auth)

3187 PLASMA EQUILIBRIUM AND CONFINEMENT IN A POLOIDAL HELIOTRON CONFIGURATION. II. Zykov, V.G.; Karpukhin, V.I.; Lonin, Yu.F.; Podteregera, N.N.; Rudnev, N.I.; Tolok, V.T. Sov. Phys.—Tech. Phys. 19: No. 8, 1069-1072 (Feb 1975).

The decay of an injected plasma [$n\gtrsim2\cdot10^{13}$ cm^{-3}, $n(T_e+T_i)\simeq5\cdot10^{14}$ eV/cm^3] has been studied in a toroidal trap with a poloidal heliotron configuration. The decay constant is found to be a function of the magnetic field H, the plasma density n, and the size of the regions in which the lines of force have an unfavorable curvature, L_∞. This functional dependence, which can be written as $\tau\sim H/nL_\infty$, is attributed to the stabilizing effect of the poloidal heliotron configuration on the instabilities due to the toroidal nature of the system. The decay constant for the plasma density is $\tau=0.5-1$ msec and, in the case $L_\infty=L/4$ is in order-of-magnitude agreement with the lifetime calculated from the measured flux of ions to the supports and coils of the opposed magnetic field, which are not completely shielded magnetically. (auth)

3188 EQUILIBRIUM IN A TOKAMAK WITH NONCIRCULAR CROSS SECTION. Zakharov, L.E. Sov. Phys.—Tech. Phys. 19: No. 8, 1005-1008 (Feb 1975).

A general method is proposed for calculating the equilibrium in a toroidal configuration with noncircular cross section. Illustrative

calculations are carried out for the equilibrium of a plasma in a chamber with cross section extended along the symmetry axis and in external fields. (auth)

3189 PLASMA CONFINEMENT BY A MAGNETIC SHELL CONFIGURATION. Weibel, E. S.; Tran, M. W. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Phys. Lett., A; 51: No. 2, 71-73(10 Feb 1975).

The confinement properties of a new magnetic shell configuration have been investigated experimentally. The diffusion coefficient D has been determined. (auth)

3190 LOWER-HYBRID PARAMETRIC INSTABILITY AND ION HEATING IN A MODULATED ELECTRON BEAM-PLASMA SYSTEM. Yatsui, K. (Osaka Univ. (Japan)). Phys. Lett., A; 51: No. 2, 109-110(10 Feb 1975).

The interaction of an electron beam modulated near the lower-hybrid frequency with a magnetoplasma is studied experimentally. At high levels of beam modulation, it is found that the beam pumps a parametric decay, and that correspondingly energetic ions are produced. (auth)

Plasma Diagnostics

Refer also to abstracts 3232, 3270, and 4428.

3191 (COO-2229-6) INVESTIGATION OF A COHERENT INSTABILITY WITH AN ION BEAM PROBE. Glowienka, J. C.; Reinovsky, R. E.; Jennings, W. C.; Hickok, R. L. (Rensselaer Polytechnic Inst., Troy, N. Y. (USA). Plasma Dynamics Lab.). 1974. Contract AT(11-1)-2229. 9p. (CONF-740559-2). Dep. NTIS $4.00.

From conference on plasma science; Knoxville, Tennessee, USA (15 May 1974).

The instability generated in a hollow cathode discharge using ion beam probing (IBP) was studied. This ion beam technique provides accurate detailed measurements of plasma number density, electron temperature, and space potential simultaneously. All measurements are made continuously with a spherical resolution volume of better than 0.1 cm^3 and time resolution of 10 mu sec. Data are presented from an experimental study using an IBP of a coherent instability at 70 to 80 kHz in a hollow cathode discharge in helium. (MOW)

3192 (IPP-4/125) INTERFEROMETRIC DENSITY MEASUREMENTS BY A CO_2-LASER AT A LASER PRODUCED PLASMA. Buechl, K.; Haering, T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Oct 1974. 58p. (In German). INIS.

The expansion of a CO_2-laser-produced plasma from a polyethylene pellet of 200μ diameter is investigated using a Mach-Zehnderinterferometer at 10.6μ. The expansion is asymmetric towards the laser. The measured density profiles are compared with calculated profiles. About 10% of the pellet atoms are ionized. Only a very small portion of the laser energy has been found in the produced plasma. (orig.)

3193 (IPPJ-DT-42) PROBE DRIVING DEVICE IN PLASMA EXPERIMENT. Pujiwaka, S.; Imai, T.; Ikezi, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1973. 20p. (In Japanese). INIS.

The probe driving device was manufactured to have the following features as the linear driving device in a plasma experiment: minimizing backlash without vacuum suction, enabling to separate drive assembly and guide rail, and probe motion being changeable by the input wave form of the power source for driving. The probe driving device consists of three parts, (1) drive assembly, (2) potentiometer, and (3) guide rail. (JA)

3194 (N-74-27623) RADIOFREQUENCY STUDIES IN THE NASA LEWIS BUMPY TORUS. Gerdin, G. A. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 18p. (CONF-740559-4; NASA-TM-X-71567; E-8003). NTIS $3.00.

From conference on plasma science; Knoxville, Tennessee, USA (15 May 1974).

The fluctuations in potential of the plasma in the NASA Lewis Bumpy Torus were observed using capacitive probes over frequencies from 1 kHz to 25 MHz and a wide range of operating conditions. The spectra were found to differ greatly above and below a background gas pressure of 3.4×10^{-5} torr deuterium. Above this pressure the spectrum was dominated by the ion spoke frequency and a spectral index was defined. Below this pressure the spectrum below 200 kHz was lower in amplitude by a factor of ten and no spectral index could be defined. At these lower pressures, fluctuations that appeared to be ion spokes were observed, but had a dependence of frequency on operating conditions which was previously unreported. (auth)

3195 (UCRL-51784) RADIAL PLASMA BUILDUP CODE FOR NEUTRAL BEAM INJECTION INTO A MIRROR MACHINE. Stallard, B. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Mar 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.00.

A computer code was developed for calculating the time-dependent radial profile of plasmas in a mirror machine built up and maintained by injection of high current, energetic neutral beams into a target plasma. The code models plasma expansion caused by ions trapped on the boundary and the competing effect of plasma erosion by charge exchange of the plasma on thermal gas at the boundary. For equilibrium the maximum allowed ratio of thermal gas current to injected beam current is determined by the geometry, ion energy and mass, and magnetic field. The computer code calculates the self-consistent thermal gas in the plasma boundary taking into account gas from the neutral beam sources, wall reflux of charge exchange neutrals, and pumping by the plasma, gettered walls, and conducting apertures in the plasma chamber. Examples are presented for beam injection into the 2XIIB mirror experiment. (auth)

3196 FAST-SCANNING FAR-INFRARED FABRY–PEROT INTERFEROMETER. Komm, D. S.; Blanken, R. A.; Brossier, P. (Massachusetts Inst. of Tech., Cambridge). Appl. Opt.; 14: No. 2, 460-464(Feb 1975).

A scanning Fabry–Perot interferometer for use in the far ir (100 mu m less than lambda less than 2 mm) has been developed capable of scanning a free spectral range in a few milliseconds. A commercial loudspeaker was used as a drive, and mirrors were fabricated from electroformed copper mesh. Primary limitations of the instrument were due to vibrations of the interferometer frame. (auth)

3197 PLASMA DIAGNOSIS BY LASER BEAM SCANNING. Cheng, T.K.; Casperson, L.W. (School of Engineering and Applied Science, University of California, Los Angeles, California 90024). J. Appl. Phys. 46: No. 5, 1961-1965 (May 1975).

A procedure is developed for determining the radial electron density and temperature profiles of a rotationally symmetric plasma. This high-resolution technique involves measuring the deflection of laser beams incident transverse to the plasma. Diagnosis of a stable atmospheric pressure argon arc with CO_2 and He-Ne laser beams yields results in good agreement with spectroscopic methods. (auth)

3198 DEPOLARIZATION OF MICROWAVES IN ELECTROMAGNETIC POLARIMETRY: INFLUENCE, DETECTION, AND MEASUREMENT. Sardos, R. (Laboratoire de Physique Expérimentale, Equipe d'Optique des Micro-ondes, Université de Bordeaux I, 351 Cours de la Libération, 33405-Talence, France). J. Appl. Phys. 46: No. 5, 1987-1993 (May 1975).

Precise polarimetric measurement with microwaves is taking on a growing interest (in plasmas and ferroelectricity, as well as Faraday, Cotton-Mouton-Voigt, Kerr, and other effects) and it is for this reason that the present author draws attention to the fact that in order to make meaningful measurements of rotation and ellipticity, account must be taken of the possible depolarization of waves. It is demonstrated that the measurement of wave depolarization can be made with the aid of a two-wave interference depolarimeter and polarimeter-ellipsometer used in conjunction with a single detector. Thus, point-by-point measurements are conducted which give simultaneously depolarization, rotation, ellipticity, and the sign of the ellipticity. It is shown that a depolarimeter and polarimeter-ellipsometer using a three-wave interferential analyzer can also be used to obtain all these values, and in addition can record their variations, which is indispensable for the study of unstable phenomena, or for a too rapid evolution where point-by-point measurements cannot be made. (auth)

3199 MEASUREMENTS OF ION WAVE TURBULENCE BY MICROWAVE SCATTERING. Mase, A.; Tsukishima, T. (Faculty of Engineering, Nagoya University, Nagoya, Japan). Phys. Fluids 18: No. 4, 464-469 (Apr 1975).

Ion wave turbulence spontaneously excited in a current-carrying plasma is investigated by the microwave scattering method. The dispersion relation, the wavenumber spectra, and the angular spectra of the ion wave turbulence are determined from the angular distribution of the scattered wave. The wavenumber spectrum has a peak around $k \simeq \nu_{in}/v_p$, and decreases as $k^{-4.8\pm0.5}$ with increasing k, where ν_{in} is the ion-neutral collision frequency and v_p is the phase velocity of the ion wave. The angular spectrum of the wave energy is found to broaden as the total wave energy, W, increases along the electron drift. The effective collision frequency, ν_f, for electrons is also measured by the rf probe method as well as the dc method. An anomalous increase in ν_f is observed with the increase in W along the electron drift. The present experimental results are consistent with the theory of perturbed ion orbits. (auth)

3200 VERSATILE PLASMA PROBE. Holmes, J.C.; Szuszczewicz, E.P. (E. O. Hulburt Center for Space Research, Naval

Research Laboratory, Washington, D.C. 20375). Rev. Sci. Instrum. 46: No. 5, 592-598 (May 1975).

We have developed a plasma probe circuit which couples standard Langmuir probe diagnostic procedures with pulse mode operation. Circuit versatility provides the means for studying time-dependent phenomena and establishes an improved capability for measuring plasma density and temperature. As an application of our circuit, we show that pulse mode operation substantially reduces the time variance of electrode surface conditions which often causes hysteresis in the Langmuir probe current-voltage characteristic. (auth)

3201 IMPEDANCE PROBE AND DC PROBE STUDIES ON A COLLISIONAL PLASMA IN AN ARC DISCHARGE. Basu, J.; Sen, C. (Saha Institute of Nuclear Physics, Calcutta-9, India). J. Appl. Phys. 46: No. 5, 2298-2300 (May 1975).

The collision-dominated plasma of a hot-cathode arc discharge in argon has been studied by a plane probe acting simultaneously as a rf impedance probe and a dc probe. Measurements carried out under different discharge conditions show that the electron temperatures, as given by the rf and dc methods, are in excellent agreement and that the corresponding electron densities agree fairly well, the agreement being better than that mentioned earlier for the plasma of a glow discharge. The thickness of the probe sheath as a function of the sheath voltage, as measured by the rf method, is reported. (auth)

3202 INVESTIGATION OF A PLASMA FOCUS WITH A TIME-RESOLVED LASER INTERFEROMETER. Zolototrubov, I.M.; Skoblik, I.P.; Tolstolutskii, A.G.; Privezentsev, V.I. Sov. Phys.—Tech. Phys. 19: No. 8, 1061-1062 (Feb 1975).

A modified Mach-Zender interferometer with a He-Ne laser as light source and an SFR rotating mirror camera for time resolution is described. By sweeping the sharply focused laser beam a time resolution of to $3 \cdot 10^{-8}$ sec is achieved. The interferometer is used to observe plasma density fluctuations and to determine the geometrical size of a plasma focus. (auth)

3203 MEASUREMENTS OF ION ACOUSTIC FLUCTUATIONS IN A LOW DENSITY PLASMA BY SCATTERING OF PULSED CO_2 LASER LIGHT. Baker, D. R.; Heckenberg, N. R.; Meyer, J. (Max-Planck-Institut fuer Plasmaphysik, Garching; Muenchen (F. R. Germany)). Phys. Lett., A; 51: No. 3, 185-187(24 Feb 1975).

The small angle scattering of infrared laser light from ion acoustic fluctuations could be an important method for measuring the ion temperature and ion turbulence spectra in fusion research plasmas. Measurements of ion acoustic waves in a low density plasma have been made by 1° scattering of pulsed CO_2 laser light. The heterodyne detection system uses stray light as local oscillator. (auth)

3204 PULSED CO_2 LASER SCATTERING FROM A HYDROGEN ARC PLASMA AND HETERODYNE DETECTION. Gondhalekar, A.; Holzhauer, E. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Plasmaforschung). Phys. Lett., A; 51: No. 3, 178-180 (24 Feb 1975).

The first plasma scattering experiment using a pulsed single frequency hybrid CO_2 laser, employing heterodyne detection to resolve the spectrum is reported. Waves propagating parallel to the electron current in a magnetically stabilized hydrogen arc plasma are detected. (auth)

3205 PICOSECOND X-RAY PLASMA RADIATION MEASUREMENTS. Brukhnevitch, G. I.; Chevokin, V. K.; Kasyanov, Yu. S.; Korobkin, V. V.; Malyutin, A. A.; Prokhorov, A. M.; Richardson, M. C.; Schelev, M. Ya.; Stepanov, B. M. (AN SSSR, Moscow. Fizicheskij Inst.). Phys. Lett., A; 51: No. 4, 249-250(10 Mar 1975).

Direct picosecond measurements of x-ray laser plasma radiation were performed with a high-speed x-ray image converter camera (ICC). This camera operates in the single-frame mode with an exposure time ranging from 5 ns to 0.5 μs and in the streak mode with 5×10^9 to 5×10^7 cm/s streak velocities. Its temporal resolution in the streak mode was calculated to be about 7 ps. A plasma was created by focussing 10 ps 1 to 2 joule laser pulses onto a titanium target placed in a vacuum chamber. The halfwidth of the recorded x-ray pulses varied from 30 to 60 ps. (auth)

3206 APPLICATION OF MATRIX ISOLATION SPECTROSCOPY FOR THE DIAGNOSTIC INVESTIGATION OF LOW PRESSURE PLASMA. The Systems Carbon/Hydrogen and Carbon/Oxygen. Veprek, S. (Zurich Univ. (Switzerland)); Cocke, D. L.; Gingerich, K. A. (Texas Agricultural and Mechanical Univ., College Station (USA). Dept. of Chemistry). Chem. Phys. (Amsterdam); 7: No. 2, 294-302(Feb 1975).

The chemical compositions of low pressure plasmas in the heterogeneous systems carbon/hydrogen and carbon/oxygen have been investigated by means of matrix isolation infrared spectroscopy. It was shown that the dominant carbon carrying species in the plasma are simple hydrocarbons and carbon monoxide, respectively. Consequences of these findings for interpretation of the mechanism of carbon transport in these systems are discussed. (auth)

3207 CULHAM'S PHOTOGRAPHIC "CONSULTANCY" SPEEDS THE SEARCH FOR SAFE NUCLEAR POWER. Warr, D. Industrial and Commercial Photographer; 15: No. 3, 38-45(Mar 1975).

An account is given of the work of the Printing and Photographic Section at the United Kingdom Atomic Energy Authority's Culham Laboratory. Examples are given of the cameras, film and other equipment used for various subjects, including the photography involved in plasma and thermonuclear research. (UK)

Plasma Kinetics (General)

3208 EMISSION, DYNAMICS, AND STABILITY OF THE LITHIUM PLASMA OR A HIGH-CURRENT DISCHARGE. Nikolaev, F. A.; Rozanov, V. B.; Sviridenko, Yu. P. Tr. Fiz. Inst., Akad. Nauk SSSR; 76: 36-74(1974). (In Russian)

Theoretical and experimental studies were carried out of a high-current, pulse, cylindrical discharge in a lithium plasma at current on the order 200 to 300 A and a duration of 10^{-4} sec. In the region of maximum current a quasistationary state is realized; the plasma is retained by the magnetic field, and all the energy introduced into the discharge is emitted. The emission spectrum has a selective character: the plasma emits, like a black body, in the visible region; on decreasing the wavelength the plasma becomes optically transparent; in this case the emission has a volumetric character. Conclusions are reached on the efficiency of this source of laser pumping. Measurements were made of the distribution of plasma discharge parameters (density, temperature, optical thickness, fluxes and emission spectrum). The time picture of the development of the discharge was investigated. Measurements were made of the characteristics of plasma inhomogeneities occurring because of the competition of superheated and force instabilities. (29 figs. 50 refs.) (SJR)

3209 EXPERIMENTAL AND THEORETICAL STUDIES OF THE DYNAMICS OF POWERFUL, LIGHT-EMITTING DISCHARGES IN GASES. Borovich, B. L.; Grigor'ev, P. G.; Zuev, V. S.; Rozanov, V. B.; Startsev, A. V.; Shirokikh, A. P. Tr. Fiz. Inst., Akad. Nauk SSSR; 76: 3-35(1974). (In Russian)

Experimental studies were conducted of the characteristics of high-current (up to 400 ka) discharges in gases at pressures up to 1 atm and energy supply of ~40 kjoules. Measurements were made of the current and voltage, rate of expansion of the channel, and absolute emission intensities at various frequencies, by means of which it was possible to compose an energy balance in the discharge. The stability of the discharges was investigated. A general physical picture was constructed of the dynamics of high-current discharges in gases, and an approximate theoretical model was developed that was based on solving the equations of gasdynamics with a nonlinear thermal conductivity and the equations of an electric circuit for the regime where a shock wave propagates in front of the thermal wave. The theoretical model was compared with exact numerical calculations, and satisfactory agreement was obtained. These relations explain the basic experimental facts, and on starting with the characteristics of the feed source, it is possible to predict the discharge parameters. (SJR)

3210 PARAMETRIC INSTABILITIES: EVALUATION OF THRESHOLDS ACCOUNTING FOR ION-ION COLLISIONS. Virmont, J. (Laboratoire de Physique des Milieux Ionisés, Equipe de recherche associée au Centre National de la Recherche Scientifique, Ecole Polytechnique, Paris, France). Phys. Fluids 18: No. 5, 570-574 (May 1975).

The linear ion susceptibility is evaluated for the cases of either weak or strong ion-ion collisions, starting from a Fokker–Planck collision term. The thresholds of the plasmon-phonon parametric instabilities are then computed under conditions of interest for the laser plasma-heating experiments. The values obtained are significantly lower than those previously published. (auth)

3211 THEORY OF ION ACCELERATION BY DRIFTING INTENSE RELATIVISTIC ELECTRON BEAMS. II. COMPARISON WITH EXPERIMENTS. Olson, C.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Fluids 18: No. 5, 598-606 (May 1975).

Predictions of a theory together with a detailed comparison of that theory with data obtained over the past six years at several laboratories are presented, and good agreement is shown for a wide variety of measurable quantities. This agreement includes the ion energy and its dependence on ion charge state, beam current, beam energy, neutral gas perameters, and guide tube and beam dimensions. It also includes the ion number and pulse shape and their variation with pressure; the

acceleration characteristics including the delay time near the anode, the acceleration region length, and the acceleration time; and the location of the ion bunch relative to the beam front. The beam front velocity and propagating beam risetime behavior are also in agreement. Effects of an external magnetic field and a plasma-filled guide are considered. In addition, radially accelerated ions, the effects of v/γ, and possible multiple pulse mechanisms are discussed. (auth)

3212 A COMPARISON BETWEEN DEBYE–HUECKEL SCREENING AND THE STARK EFFECT ON THE DETERMINATION OF THE LAST OBSERVABLE SPECTRAL LINE FROM A HYDROGEN-LIKE PLASMA. Roussel, K. M.; O'Connell, R. F. (Louisiana State Univ., Baton Rouge (USA). Dept. of Physics and Astronomy). Phys. Lett., A; 51: No. 4, 244-246 (10 Mar 1975).

An analytical expression is derived for the critical temperature which marks the boundary between the two regimes in which the disappearance of spectral lines (emitted by transitions from levels near the continuum) from a hydrogen-like plasma is caused by either the Inglis Teller effect or the Debye-Hückel screening effect. (auth)

3213 RECOMBINATION PROCESSES IN A CAESIUM AFTERGLOW IN THE PRESSURE RANGE $0.06 \leq p-C-s \leq 0.4$ TORR. Sayer, B.; Jeannet, J. C.; Saint-Hilaire, G.; Lozingot, J.; Berlande, J. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys., B (London); 8: No. 3, 503-511(21 Feb 1975).

The results of an experimental investigation of the electron density decay in a caesium afterglow ($0.06 \leq P_{Cs} \leq 0.4$ Torr, $10^9 \leq n_e \leq 10^{11}$ cm^{-3}) are presented and compared with previous experimental results. The authors show that the large recombination coefficients which are measured (up to several 10^{-7} cm^3 s^{-1}) cannot be interpreted as due to dissociative recombination of diatomic caesium ions but involve heavier ions such as Cs_3^+. (auth)

Plasma Kinetics (Experimental)

3214 SECOND-HARMONIC GENERATION IN AN INHOMOGENEOUS LASER-PRODUCED PLASMA. Eidmann, K.; Sigel, R. (Max-Planck-Institut für Plasmaphysik-EURATOM Association, 8046 Garching, Germany). Phys. Rev. Lett. 34: No. 13, 799-802 (31 Mar 1975).

It is experimentally shown that specular second-harmonic emission from a dense, inhomogeneous plasma produced by laser irradiation of plane solid targets occurs on oblique reflection of a *p*-polarized light wave, in agreement with theoretical predictions. (auth)

3215 OBSERVATION OF HYDROGEN AND HELIUM SATELLITES IN A TURBULENT PLASMA. Gallagher, C. C.; Levine, M. A. (Alloyd Research Corp., Watertown, MA). J. Quant. Spectrosc. Radiative Transfer; 15: No. 3, 275-279(Mar 1975).

Time-resolved measurements of satellites about the (1s2s-1s3d) forbidden transition in helium, satellites both of the H_δ line of hydrogen and of its splittings and, finally, satellites of He II 4686 Å have been observed. The behavior of these satellites is correlated relative to each other and to previously reported satellites both on H_β and near the 6632 Å (1s2p-1s3p) forbidden transition in helium. The appearance of the satellites is attributed to a strong field interaction between orthogonal components of the dynamic and quasistatic electric fields generated in a plasma by an instability. (auth)

Plasma Kinetics (Theoretical)

3216 (AD/A-002196) THERMODYNAMICS OF NEGATIVE-TEMPERATURE EQUILIBRIA IN GUIDING-CENTER PLASMAS. Book, D. L.; Fisher, S.; McDonald, B. E. (Naval Research Lab., Washington, D. C. (USA)). Oct 1974. 10p. (NRL-MR-2924). NTIS $3.25.

The Sinh-Poisson equation describing two-dimensional steady state distrubutions of elements with a logarithmic interaction potential (charged filaments executing guiding center motion; quantized vortex lines or rotons) is solved numerically. Multiple solutions are obtained for the case of negative temperatures. These have a simple thermodynamic interpretation which agrees with the results of numerical simulations. The results are related to numerical experiments and observations of vortex filaments in liquid ^{4}He. (GRA)

3217 (IPP-1/150) EQUILIBRIUM AND STABILITY INVESTIGATIONS IN THE BELT PINCH. Krause, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Sep 1974. 70p. INIS.

The first part of this report therefore deals with the production and investigation of belt pinch equilibria. The second part is concerned with checking the basic condition for predicting favorable properties resulting from elongated plasma cross-sections, namely that the safety factor at the stability limit is independent of the elongation. For this purpose the plasma current in a belt pinch equilibrium with strong elongation (axis ratio approximately 6) is raised to the stability limit and the corresponding safety factor measured directly. (orig./TK)

3218 (UCRL-75877) TWO-DIMENSIONAL SIMULATION OF HYDRODYNAMIC INSTABILITY IN LASER FUSION IMPLOSIONS. Mead, W. C.; Lindl, J. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 29p. (CONF-741079-11). Dep. NTIS $4.50.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

The fluid instabilities are studied by applying a perturbation to a spherical shell or solid drop, then observing the amplitude of the disturbance as a function of time and position as the acceleration or implosion takes place. Several measures of amplitude were monitored, but surface deformation was usually found to be the most useful for characterizing behavior of the system under study. Computer code tests and anomalies are discussed. Current understanding of fluid instability in the presence of ablation is described. (MOW)

3219 EFFECT OF NEGATIVE IONS ON CURRENT GROWTH AND IONIZING WAVE PROPAGATION IN AIR. Kline, L.E. (Westinghouse Research Laboratories, Pittsburgh, Pennsylvania 15235). J. Appl. Phys. 46: No. 5, 1994-2000 (May 1975).

The spatiotemporal development of electron and ion densities, electric fields, and luminosity are calculated for electron pulse experiments in overvolted parallel-plane gaps by numerically solving continuity equations together with Poisson's equation. Experimental coefficients for primary ionization, cathode photoemission, photoionization, and luminosity are used. Unambiguous determination of the coefficients for attachment, detachment, and charge transfer is not possible from available experimental results. Therefore, the calculations are repeated for three sets of coefficients for these processes, corresponding to the following assumptions: unstable negative ions, stable negative ions, and no negative ions. The results of the calculations show, in each case, that the electron pulse initiates an avalanche which grows exponentially until the onset of space-charge effects. The calculated growth rate is strongly affected by the assumed attachment, detachment, and charge-transfer coefficients. When the total number of electrons in the avalanche reaches $\approx 10^8$, anode- and cathode-directed ionizing waves, or streamers, develop from the avalanche and produce a weakly ionized filamentary plasma. The calculated ionizing wave velocities are strongly increasing functions of the space-charge-enhanced electric field within the waves and are insensitive to the assumed attachment, detachment, and charge-transfer coefficients. The numerically calculated ionizing wave velocities are in approximate agreement with a simple analytical theory. (auth)

3220 NUMERICAL SIMULATION OF SHOCK-HEATED PLASMA WITH A MAGNETIC DAM. Todd, A.M.M. (Plasma Physics Laboratory, Columbia University, New York, New York 10027). Phys. Fluids 18: No. 4, 453-457 (Apr 1975).

The results of the two-dimensional numerical simulation of an ideal magnetohydrodynamic high beta shock tube plasma with a magnetic dam are presented. The dam is created by an external coil and drives into the plasma behind the shock, preventing the immediate loss of the shock-heated plasma. The problem corresponds mathematically to a hyperbolic transverse flow plasma region coupled across several free boundaries to various elliptic vacuum regions, and is solved using a particle code for the plasma dynamics, and over relaxation for the vacuum regions. The results obtained show that such a dam will lengthen the lifetime of the shock-heated plasma. (auth)

3221 DENSITY PERTURBATION INFLUENCE ON NONLINEAR HARMONIC EXCITATION AT THE UPPER HYBRID RESONANCE. Cano, R.; Fidone, I.; Hosea, J.C.; Schuss, J.J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 18: No. 4, 491-493 (Apr 1975).

The cold plasma theory of upper hybrid harmonic generation is examined numerically. Inclusion of the density perturbation caused by incident wave pressure gives enhanced harmonic levels (as observed experimentally) and reveals the sensitivity of the theory to the description of the incident fields. (auth)

3222 STARK BROADENING OF THE OVERLAPPING 4471.48 Å HeI LINE IN A PLASMA. II. NONMARKOVIAN AND ION DYNAMIC EFFECTS. Sassi, M. (Département de Recherches Physiques, Faculté des Sciences, 75005 Paris, France); Deutsch, C.; Coulaud, G. Ann. Phys. (N.Y.) 89: No. 2, 274-283 (Feb 1975).

The inclusion of a frequency-dependent collision operator in the line shape expression is investigated quantitatively for the 4471 Å overlapping HeI line. We compare at several electron densities frequency-independent (markovian) profiles with frequency-dependent (nonmarkovian) profiles taking into account incomplete electron-atom collisions. No significant discrepancies appear in the domain of validity of the impact approximations ($|\Delta\omega| \ll \omega p_e$), whereas for the far wings

important differences may be found. At the extrema (two peaks, one dip) the nonmarkovian intensities prove to be the higher ones. For a modest electron density, the inclusion of ion dynamic shielding introduces more modifications than nonmarkovian effects. In the blue wing, the frequency-dependent profile lies below the frequency-independent profile in accord with the hydrogenic behavior for that part of the line shape in the presence of a large perturber density. (auth)

3223 ENERGY LOSS OF A RELATIVISTIC, FINITE ELECTRON BEAM IN A PLASMA. Gerwin, R.A. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). Phys. Fluids 18: No. 5, 614-615 (May 1975).

The rate of energy dissipation by the beam-induced reverse current in a resistive plasma is calculated numerically with emphasis on the effects of finite beam radius and length. (auth)

3224 THEORY OF ION ACCELERATION BY DRIFTING INTENSE RELATIVISTIC ELECTRON BEAMS. I. THEORY. Olson, C.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Fluids 18: No. 5, 585-597 (May 1975).

A theory that describes the collective acceleration of ions by an intense relativistic electron beam injected into a metallic guide tube filled with neutral gas at low pressure is presented. The acceleration mechanism is shown to be of electrostatic origin (although it is different from those employed in previous electrostatic theories), and its many parametric dependences are identified and discussed. In the theory, ion acceleration occurs in the electrostatic fields of a two-dimensional, time-dependent, potential well, which is described by the *self-consistent* coupling of the beam dynamics with the ionization processes of the neutral gas. The theory divides into the cases (i) $I_0 \gtrsim I_l$, and (ii) $I_0 \ll I_l$, where I_0 is the peak injected beam current and I_l is the space-charge limiting current. For case (i), the beam initially stops at the anode and creates a deep potential well. At roughly the charge neutralization time, a nonadiabatic transition occurs, the beam begins to propagate, and an ion bunch is accelerated. At low pressures, the ion energy per ion charge may be up to three times the injected electron energy. At higher pressures, the ion energy per ion charge may exceed three times the injected electron energy. At still higher pressures, ion acceleration ceases due either to beam front runaway, ion slip-out, or charge-exchange effects. For case (ii), the beam never stops at the anode, a deep well is never created, and no accelerated ions should occur. All existing ion acceleration data is in the regime $I_0 \gtrsim I_l$, although this was not previously recognized. The effects of ion impact ionization, ion avalanching, and charge exchange (neglected in all previous theories) are shown to play important, and sometimes dominant, roles in the acceleration process. (auth)

3225 THREE-DIMENSIONAL EQUILIBRIUM OF THE ANISOTROPIC, FINITE-PRESSURE GUIDING-CENTER PLASMA: THEORY OF THE MAGNETIC PLASMA. Hall, L.S.; McNamara, B. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Fluids 18: No. 5, 552-565 (May 1975).

Theoretical and numerical methods now give a complete solution to the problem of finite-β plasma equilibrium in mirror magnetic wells and toroidal devices. The equilibria can be made consistent on all of the progressively longer time scales of the guiding-center fluid model, including the particle magnetic drifts and the Coulomb scattering equilibration of a neutral injected plasma. The theory of equilibrium in the guiding-center fluid model of a finite-β plasma with an arbitrary, anisotropic pressure tensor can be formulated as a classical magnetostatic system: $\nabla \cdot B = 0$, $\nabla \times H = 0$, $B = H + 4\pi M(B)$. The plasma magnetization is found explicitly in terms of three physically distinct components related to the laws of conservation of magnetic moment, of longitudinal invariant, and of the sign of the velocity along B of particles that do not undergo mirror reflection. A condition is derived upon the field geometry whereby a large class of special equilibria can be found in which all particles on a given line drift on the same surface, the omnigenous surface. Such systems allow a specially simple connection between particle and fluid models in the guiding-center fluid theory. The usefulness of the theory is exemplified by application to the problem of a finite-β plasma in a magnetic well. Finally, a brief treatment of stability in terms of the energy principle is given. The omnigenous equilibria have particularly simple stability criteria. (auth)

3226 EXACT EQUILIBRIA OF AXISYMMETRIC MAGNETIC CONFIGURATIONS. Mazzucato, E. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 18: No. 5, 536-540 (May 1975).

A class of solutions of the ideal magnetohydrodynamic equilibrium equations of an axisymmetric magnetic configuration is derived. These solutions, besides including magnetic configurations with a large variety of cross sections and nonuniform current distributions, are exact solutions obtained without making any assumptions on the value of the aspect ratio. The stability of some of these configurations with respect to ideal localized modes has been numerically evaluated. (auth)

3227 LASER BEAM SELF-FOCUSING IN GASES. Skupsky, S.; Osborn, R. K. (Univ. of Michigan, Ann Arbor). Nuovo Cim., 26B: No. 1, 181-190(11 Mar 1975).

A new mechanism which may cause self-focusing in gases is proposed. The case of a one-hundred picosecond pulse interacting with a monoatomic gas is considered. Under these conditions of short time, low density and spherical atomic symmetry, the usual self-focusing mechanisms such as the Kerr effect may not be applicable. Since there are indications that self-focusing does occur under these conditions, one is led to seek new sources of nonlinearity in the wave equation. The one suggested here is multiphoton Raman scattering. For a sufficiently intense beam this should be a very rapid process and produce observable effects even under the afore-mentioned conditions. These initial calculations indicate that this indeed may be the cause of self-focusing in gases. (auth)

3228 THERMODYNAMIC FUNCTIONS OF DENSE EQUILIBRIUM PLASMAS USING THE ALLNATT INTEGRAL EQUATION. Saendig, R. (Rostock Univ. (German Democratic Republic). Sektion Physik). Phys. Lett., A; 51: No. 3, 181-182(24 Feb 1975).

Solving the nonlinear Allnatt integral equation in the HNC-approximation the radial distribution functions (rdf) and thermodynamic functions for the subsystem of free electrons and ions in a dense plasma were calculated. (auth)

3229 EFFECTS OF DYNAMICAL FRICTION ON THE RENORMALIZATION OF PROPAGATOR IN TURBULENT PLASMAS. Kono, M. (Kyushu Univ., Fukuoka (Japan). Research Inst. for Applied Mechanics); Sanuki, H. (Stevens Inst. of Tech., Hoboken, N. J. (USA). Dept. of Physics); Todoroki, J. (Nihon Univ., Tokyo. Coll. of Science and Engineering). Phys. Lett., A; 51: No. 4, 247-248(10 Mar 1975).

It is shown that there appear two stages in effects of fluctuations on particle trajectories in weakly turbulent plasmas. A new propagator including dynamical friction is obtained, which is different from the Dupree type one. (auth)

Plasma Production

Refer also to abstract 3218.

3230 (UCRL-76210(Rev.1)) LASER PLASMA EXPERIMENTS RELEVANT TO LASER PRODUCED IMPLOSIONS. Ahlstrom, H. G.; Holzrichter, J. F.; Manes, K. R.; Coleman, L. W.; Speck, D. R.; Haas, R. A.; Shay, H. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1974. 63p. (CONF-741105-55). Dep. NTIS $6.25.

From 5th conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

Preliminary laser target interaction studies designed to provide code normalization data in a regime of interest to laser fusion are reported. The laser facilities constructed for such studies, the target diagnostic systems, and preliminary experimental results are described. (auth)

3231 APPLICATION OF STRONG RELATIVISTIC ELECTRON BEAMS IN THE STUDY OF CONTROLLED THERMONUCLEAR FUSION. Chao, N. M. (Ch'in-hau Univ., China). Wu-li; 3: No. 5, 290-292(18 Oct 1974). (In Chinese).

The concept of pulse-controlled fusion is introduced and its advantages are discussed; specifically, it is pointed out that the difficulties of instability in conventional fusion techniques can be avoided and the construction costs of pulsed fusion devices are lower. The pros and cons of targeting techniques using a laser beam and an electron beam are compared. In addition, the structure of a typical strong electron beam generator is described and the conditions under which a small nuclear emplosion can be ignited are estimated. The mechanism of interaction between the electron beam and the target is discussed. (JPRS)

3232 CHARGE-SEPARATION ELECTRIC FIELDS IN LASER PLASMAS. Mendel, C.W. Jr.; Olsen, J.N. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. Lett. 34: No. 14, 859-862 (7 Apr 1975).

Space-charge-separation electric fields have been measured in the expansion of laser plasmas generated by 40-psec, 1.06-μm laser pulses. The measurements were made at 2.5 and 5.0 mm from the carbon targets and on nanosecond time scales. Measured electric fields were as high as 1900 V/cm and exceed those expected from theory. (auth)

3233 DUOPIGATRON II ION SOURCE. Davis, R.C.; Jernigan, T.C.; Morgan, O.B.; Stewart, L.D.; Stirling, W.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Rev. Sci. Instrum. 46: No. 5, 576-581 (May 1975).

The DuoPIGatron ion source concept at Oak Ridge has proven itself capable of providing multiampere beams at tens of kilovolts. The DuoPIGatron II operates very reliably at 6–8 A total output current in the 25–35 kV range. Impurity level is easily maintained below 0.4% and the 0.2 sec pulses show no appreciable wear on the copper accel–decel electrode system after thousands of pulses with duty cycles up to 10%. The 7 cm diam grids are 50% transparent and optimum curvature of the grids allows about 60%–65% of the current to be incident on a 9 cm diam target 100 cm from the source. Beam ion and neutral species fractions have been measured as a function of total source current. Studies of the ion source plasma show an $m=1$ helical instability to be present. Probe measurements show a density variation of about 25%–30% across the extraction grid. Instantaneous density variations from ± 10% to ± 40%, depending on radius, are observed to be driven by the instability at 250–400 kHz. A stabilizer has been developed which reduces the oscillation amplitude by about an order of magnitude. Studies at extraction voltages up to 10 kV show that the use of the stabilizer yields a less divergent beam and higher current output through a single aperture either on axis or 1.8 cm from the source axis. (auth)

3234 STUDY OF THE PARAMETERS AND DYNAMICS OF A LASER PLASMA WITH SHARP FOCUSING OF THE RADIATION ON A SOLID TARGET. Boiko, V. A.; Krokhin, O. N.; Sklizkov, G. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 76: 186-228(1974). (In Russian).

A review is presented of the physical conditions existing in a laser plasma on irradiating a solid target in vacuum at a flux density of ~10^{10} to 10^{15} watts/cm^2 and a light pulse duration of 10^{-11} to 10^{-8} sec. Results and discussions are presented of various experiments on determining the maximum electron temperature of a plasma, electron density, ion lifetime in the hot spot, plasma disintegration rate and maximum multiplicity of the ions which are respectively: T_e is 0.01 to 2.0 kev; N_e is ~10^{20} cm^{-3}; τ is ~10^{-9} sec; v is ~ 10^7 cm/sec, and z is 20. On the basis of these data a discussion is presented of a model for the dynamic motion of the plasma, and of a model of the ionization equilibrium in the hot spot. (SJR)

3235 IONIC COMPOSITION IN A POTASSIUM–NITROGEN DISCHARGE PLASMA. Morgulis, N.D.; Przhonskii, A.M. (Kiev State University). JETP Lett. 20: No. 11, 321-322 (5 Dec 1974).

The mass spectrum of the ions in a mixed $K-N_2$ plasma was investigated in a wide range of pressures. In addition to the different potassium and nitrogen ions, we observed here the complex ions KN_2^+ and an influence of the nitrogen on the formation of the K_2^+ ions; the possible nature of these phenomena is discussed. (auth)

3236 MEASUREMENT OF NON-THERMAL ELECTRON ENERGY DISTRIBUTIONS IN HIGH TEMPERATURE LASER PRODUCED PLASMAS. Key, M. H. (Queen's Univ., Belfast). J. Phys., B (London); 8: No. 4, 674-683(11 Mar 1975).

Measurement of the electron energy distribution in high temperature laser-produced plasmas is discussed. The problem arises in thermonuclear fusion research with lasers, where strong enhancement of the high energy tail of the distribution may occur. It is shown that a method based on x-ray bremsstrahlung intensity, recorded as a function of metallic absorber thickness, is applicable in the energy range 1 to 40 keV. Two stages of deconvolution to obtain first the x-ray spectrum and second the electron energy distribution are considered. Simple semi-analytic methods of sufficient accuracy for experimental work are outlined and their regime of validity discussed. (auth)

3237 TARGET INFLUENCE ON TEA–CO_2 LASER PRODUCED PLASMAS IN AIR AT ATMOSPHERIC PRESSURE. Apostol, I.; Dragulinescu, D.; Grigoriu, C. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 9, 895-898(1974).

Plasma production experiments in air at atmospheric pressure, using a double discharge, Lamberton and Pearson type, TEA–CO_2 laser, with xylene vapors addition to the active mixture, are reported. The air breakdown in front of an aluminium target was obtained for incident laser intensities of two orders of magnitude lower than the breakdown threshold intensities in air at atmospheric pressure. The radiation driven detonation wave intensity threshold was also measured and found to be ~4.0×10^7 W/cm^2, in very good agreement with Raizer's theory predicted values. (auth)

Plasma Stability

Refer also to abstract 3190.

3238 (MATT-1127) MICROINSTABILITY THEORY OF TWO-ENERGY-COMPONENT TOROIDAL SYSTEMS. Berk, H. L.; Horton, W. Jr.; Rosenbluth, M. N.; Rutherford, P. H. (Princeton Univ., N. J. (USA). Plasma Physics Lab.). Apr 1975. Contract AT(11-1)-3073. 98p. Dep. NTIS $8.00.

The microinstability theory of the two-energy-component toroidal system is developed and applied to systems typical of those in proposed fusion breakeven experiments. The energetic ion beam distributions F/sub b/ (v/sub parallel/, v/sub perpendicular/, t) obtained from approximate solutions of the Fokker–Planck equation are studied for high frequency microinstabilities arising from deltaF/sub b//deltav^2/sub parallel/ greater than or deltaF/sub b//deltav^2/sub perpendicular/ greater than 0 in both transient and collisional equilibrium states. For typical beam-plasma parameters the system is shown to be stable to high frequency modes during the parallel injection of a continuous, monoenergetic source. (auth)

3239 (UCRL-75879) EFFECTS OF RAYLEIGH TAYLOR INSTABILITY ON THE IMPLOSION OF LASER FUSION TARGETS. Lindl, J.; Mead, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 21p. (CONF-741079-10). Dep. NTIS $4.25.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

Lasnex calculations indicate that targets of pure DT with r/DELTA r ratios of 3-1 or less can be successfully imploded in the presence of Rayleigh-Taylor instability with an initial surface perturbation of at least 5 A. Further calculations are being carried out using an impulsive acceleration technique which we expect will increase the tolerable surface perturbation. However, the peak amplitude is expected to be considerably less than 100 A for a 3-1 shell. These calculations were done at the 100 kJ level, however, the number of generations of growth n approximately 2 root 2pimr/DELTAxo (1-epsilon) is almost independent of the size of the target. Thus one can tolerate a surface perturbation which increases linearly with radius. The tolerable surface perturbation would increase somewhat faster than linearly. Larger targets require somewhat lower implosion velocities, and hence, somewhat lower driving pressures. The lower driving pressure results in somewhat thicker shells and hence, longer worst unstable wavelengths. No evidence is seen of any ablation stabilization mechanism that is strong enough to be of any use to pellet design. Unless Lasnex is making some systematic error, the conclusion is that targets designed for high compression and gain will have to be manufactured very carefully if they are to survive this instability. (auth)

3240 PARAMETRIC INSTABILITY OF A SPATIALLY MODERATED ELECTRON BEAM IN A MAGNETIC FIELD. Repalov, N. S.; Tyrnov, V. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 19: No. 7, 871-873(Jan 1975).

Translated from Zh. Tekh. Fiz; 44: No. 7, 1389-1394(Jul 1974).

The parametric instability of an electron beam modulated by a spatially periodic electric field and focused by a uniform magnetic field is studied. It is shown that the development of a longitudinal instability characteristic of a beam in a magnetic field broadens the range of frequencies for which parametric amplification is possible and lowers the requirements imposed on the perveance of the beam. (auth)

3241 DETERMINATION OF SUPRATHERMAL ELECTRON DISTRIBUTIONS IN LASER-PRODUCED PLASMAS. Slivinsky, V.W.; Kornblum, H.N.; Shay, H.D. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). J. Appl. Phys. 46: No. 5, 1973-1975 (May 1975).

A *K*-edge filter technique was used to measure absolutely the x-ray emission from laser-heated CD_2 plasmas from 1 keV to above 100 keV. A Nd : glass laser system supplied a focused pulse of about 25 J in 4 nsec. The measurements clearly differentiate the suprathermal from the thermal portion of the x-ray spectrum. Thus, for the first time, we can determine the relative intensity of the high-energy x rays. The results are compared with two-dimensional energy-transport hydrodynamic code calculations. (auth)

3242 SATURATION OF THE RELATIVISTIC TWO-STREAM INSTABILITY BY ELECTRON TRAPPING. Lampe, M.; Sprangle, P. (Naval Research Laboratory, Washington, D.C. 20375). Phys. Fluids 18: No. 4, 475-481 (Apr 1975).

The single-wave weak cold relativistic two-stream instability has been studied in one dimension by numerical integration of the equations of motion, energy conservation, and Poisson's equation. The dynamics is shown to depend only on the single parameter $S = \beta_0^2\gamma_0(n_b/2n_p)^{1/3}$. The nondimensionalized wave energy at initial saturation due to beam trapping, $W_1 = \langle E \rangle 8\pi n_b mc^2\gamma_0$, reaches a maximum $W_1 = 0.09$ at $S = 0.4$ and then decreases with S, but if $S \gtrsim 0.5$ the wave energy is larger at subsequent bounces of the trapped particles, so that W_{max} increases roughly monotonically with S, reaching 0.11 at $S = 3$. The drop-off of $W_1(S)$ is due to a relativistic tendency of beam electrons to bunch in the part of the orbit where the beam electron energy is largest. The self-consistent nonlinear shifts in wave frequency and amplitude are shown to play an essential role in extracting energy from the beam. (auth)

3243 INFINITE WAVELENGTH KINK INSTABILITIES IN UNIFORM CURRENT CYLINDRICAL PLASMAS WITH RECTANGULAR CROSS SECTIONS. Rosen, M.D. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 18: No. 4, 482-486 (Apr 1975).

The magnetohydrodynamic stability of a free-boundary straight plasma column with a slightly elongated rectangular cross section, carrying a uniform axial current, is investigated analytically. Axisymmetric modes ($n = 0$), for which the circular cross section case is marginally stable ($m = 1$), are considered. Stability is found for a rigid vertical displacement, in good agreement with numerical results. However, a vertical displacement with a small additional $m = 3$ like perturbation, localized near the plasma surface, leads to instability. (auth)

3244 HYDRODYNAMIC STABILITY OF THE URAGAN STELLARATOR. Zalkind, V.M.; Kuznetsov, Yu.K.; Pashnev, V.K.; Tonkopryad, V.M. Sov. Phys.—Tech. Phys. 19: No. 8, 1123-1125 (Feb 1975).

The hydrodynamic stability of the $l=3$ Uragan stellarator has been studied by measuring magnetic-field perturbations outside the plasma. A hydrodynamic instability has been studied. The perturbations have the spatial structure m=1, n=1. The possible connection between the hydrodynamic perturbations and the macroscopic plasma instability observed for increasing current is discussed. (auth)

3245 PLASMA DECAY INSTABILITY IN CROSSED FIELDS. Farenik, V.I.; Vlasov, V.V.; Rozhkov, A.M.; Kozharin, A.A. (A. M. Gor'kii Khar'kov State University). Sov. Phys.—Tech. Phys. 19: No. 8, 1116-1117 (Feb 1975).

An experimental study is made of the nonlinear interaction of characteristic plasma oscillations which obey the decay conditions over a wide range of external fields. (auth)

3246 LOW-FREQUENCY OSCILLATIONS IN COUNTER-STREAMING HIGH-CURRENT ELECTRON BEAMS. Timoshenko, A.F.; Iremashvili, D.V.; Udovichenko, Yu.K. Sov. Phys.—Tech Phys. 19: No. 8, 1038-1041 (Feb 1975).

Low-frequency (lf) oscillations are investigated experimentally in counterstreaming beams in a background plasma in a homogeneous magnetic field. The current is 3 A, the electron beam energy is 25 keV, and the magnetic field varies from 250 to 1000 Oe. The counterstreaming beams are produced by reflection of the electron beam from a negative electrode. The oscillation frequency is close to the ion plasma frequency; the oscillations are radial oscillations of the density. These oscillations cause periodic excitation of high-frequency (hf) oscillations at half the electron cyclotron frequency and its harmonics $n\omega_H/2$ ($n = 1,2,3,...$). The lf oscillations can result from the interaction of drift instabilities in the counterstreaming beams. The current cutoff due to the lf oscillations limits the amplitude of the hf oscillations. (auth)

3247 INVESTIGATION OF LASER—PLASMA EMISSION IN THE X-RAY BAND. Kas'yanov, Yu.S.; Korobkin, V.V.; Pashinin, P.P.; Prokhorov, A.M.; Chevokin, V.K.; Shchelev, M.Ya. (P.N. Lebedev Physics Institute, USSR Academy of Sciences). JETP Lett. 20: No. 11, 333-334 (5 Dec 1974).

Investigations of a laser plasma were made in the x—ray band. It is shown that instabilities can occur in the plasma. (auth)

3248 ABSOLUTE PARAMETRIC INSTABILITY IN A TURBULENT, INHOMOGENEOUS MEDIUM. Spatschek, K. H.; Shukla, P. K.; Yu, M. Y. (Bochum Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Phys. Lett., A; 51: No. 3, 183-184(24 Feb 1975).

It is shown analytically that the convective saturation of parametric instabilities in an infinite inhomogeneous medium can disappear in the presence of background turbulence. Absolute instability then occurs. (auth)

3249 ROLE OF STREAMING PLASMA INSTABILITIES IN PARALLEL SHOCK WAVE STRUCTURES. Cipolla, J. W.; Golden, K. I. (Northeastern Univ., Boston, Mass. (USA)). Phys. Lett., A; 51: No. 4, 251-252(10 Mar 1975).

A parallel shock structure is modeled as regions of interpenetrating streams of cold unshocked ions and hot shocked ions. The linear dispersion theory predicts that unstable whistlers can stand at the leading edge of weak and intermediate strength shocks. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstracts 3178 and 3241.

3250 (BNL-19621) CONTROLLED THERMONUCLEAR REACTOR FUSION POWER TECHNOLOGY. Application of CTR to the Chemical and Materials Processing Industry. Progress Report No. 6, October—December 1974. Steinberg, M. (Brookhaven National Lab., Upton, N. Y. (USA)). Jan 1975. 35p. Dep. NTIS $4.75.

The studies being pursued at present are as follows: (1) Synthetic fuel production; the recovery of CO_2 from the atmosphere as a source of carbon for both synthetic fuel and food production is being studied. An economy free from fossil fuel for production of hydrocarbon products and based on CTR, air and water is visualized. Energy balances, process designs and cost estimates are being made. (2) Direct electrolytic reduction of CO_2; the direct electrolytic reduction of CO_2 is being studied. Products such as methanol, formates, oxalates and glycollates can be formed using CTR energy which serve as a basis for synthetic hydrocarbons for food and fuel production. (3) Food production; a survey is being made of the use of CTR for supplying energy to the growth and processing of food. Both conventional and advanced systems and processes are being pursued. (4) Steel industry; the application of CTR energy to the reduction of iron ore for steel manufacture and the reprocessing of scrap is being made. (5) Neutron-gamma radiation chemonuclear CTR blanket studies; studies are being made on the design of chemical process blankets to utilize the neutron-gamma radiation from CTR reactors. The two CTR chemonuclear processes being designed are for the decomposition of CO_2 to CO and O_2 for the production of synthesis gas (CO and H_2) and the synthesis of ozone (O_3) from oxygen. (auth)

3251 (BNL-20016) USE OF CONTROLLED THERMONUCLEAR REACTOR FUSION POWER FOR THE PRODUCTION OF SYNTHETIC METHANOL FUEL FROM AIR AND WATER. Steinberg, M.; Vi Duong Dang. (Brookhaven National Lab., Upton, N. Y. (USA)). Apr 1975. 73p. Dep. NTIS $5.45.

Methanol synthesis from carbon dioxide, water and nuclear fusion energy is extensively investigated. The entire system is analyzed from the point of view of process design and economic evaluation of various processes. The main potential advantage of a fusion reactor (CTR) for this purpose is that it provides a large source of low cost environmentally acceptable electric power based on an abundant fuel source. Carbon dioxide is obtained by extraction from the atmosphere or from sea water. Hydrogen is obtained by electrolysis of water. Methanol is synthesized by the catalytic reaction of carbon dioxide and hydrogen. The water electrolysis and methanol synthesis units are considered to be technically and commercially available. The benefit of using air or sea water as a source of carbon dioxide is to provide an essentially unlimited renewable and environmentally acceptable source of hydrocarbon fuel. Extraction of carbon dioxide from the atmosphere also allows a high degree of freedom in plant siting. (auth)

3252 (BNWL-SA-5229) SENSITIVITY STUDY OF DATA DEFICIENCIES, WEIGHTING FUNCTIONS, AND 14 MeV NEUTRON SOURCE SPECTRUM EFFECTS IN A ^{238}U FUELED FUSION-FISSION HYBRID BLANKET. Leonard, B. R. Jr.; Jenquin, U. P.; Lessor, D. L.; Newman, D. F.; Stewart, K. B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1975. Contract AT(45-1)-1830. 4p. (CONF-750303-59). Dep. NTIS $4.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

Neutronic calculations were made for a hybrid DT fusion reactor blanket in which the initial region is fueled with depleted uranium followed by lithium and graphite. The important parameters of the blanket are the tritium production, fissions, ^{239}U captures, and thermal flux in the graphite. The sensitivity of these integral parameters was studied as a function of ^{238}U region thickness and the ^{238}U microscopic data used. In particular, the effect of modifying some improbable secondary neutron energy distributions of ^{238}U on both versions III and IV of ENDF/B was calculated. Calculations were made for multigroup data obtained by collapsing over constant and E^{-1} weighting functions below the fusion peak. Results were also obtained for a narrow DT fusion neutron peak and for a neutron source distribution resulting from an essentially exact calculation of a mirror plasma driven by 100-keV neutrals. (auth)

3253 (ERDA-4) DCTR FUSION—FISSION ENERGY SYSTEMS REVIEW MEETING, DECEMBER 3—4, 1974, GERMANTOWN, MARYLAND. (Energy Research and Development Administration, Washington, D. C. (USA)). 1974. 385p. (CONF-741237-). Dep. NTIS $10.60.

Separate abstracts were prepared for eight of the included papers. The two remaining papers appeared previously in Nuclear Science Abstracts. (MOW)

For abstracts of individual papers see: 3254—3261.

3254 (ERDA-4, pp 27-61) FUSION–FISSION ENERGY SYSTEMS, SOME UTILITY PERSPECTIVES. Huse, R. A. (Public Service Electric and Gas Co., Newark, NJ); Burger, J. M.; Lotker, M. 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

Some of the issues that are important in assessing fusion–fission energy systems from a utility perspective are discussed. A number of qualitative systems-oriented observations are given along with some economic quantification of the benefits from fusion–fission hybrids and their allowed capital cost. (MOW)

3255 (ERDA-4, pp 63-91) FISSION–FUSION SYSTEMS: CLASSIFICATION AND CRITIQUE. Lidsky, L. M. (Massachusetts Inst. of Tech., Cambridge). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

A useful classification scheme for hybrid systems is described and some common features that the scheme makes apparent are pointed out. The early history of fusion-fission systems is reviewed. Some designs are described along with advantages and disadvantages of each. The extension to low and moderate Q devices is noted. (MOW)

3256 (ERDA-4, pp 93-115) ECONOMIC REGIMES FOR FISSION–FUSION ENERGY SYSTEMS. Deonigi, D. E. (Battelle Pacific Northwest Labs., Richland, WA). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

The objectives of this hybrid fusion-fission economic regimes study are to: (1) define the target costs to be met, (2) define the optimum fissile/electrical production ratio for hybrid blankets, (3) discover synergistic configurations, and (4) define the windows of economic hybrid design having desirable cost/benefit ratios. (MOW)

3257 (ERDA-4, pp 117-171) REVIEW OF BATTELLE-NORTHWEST TECHNICAL STUDIES ON FUSION–FISSION (HYBRID) ENERGY SYSTEMS. Liikala, R. C.; Leonard, B. R. Jr.; Wolkenhauer, W. C.; Aase, D. T. (Battelle Pacific Northwest Labs., Richland, WA). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

A variety of studies conducted over the past few years and the principal results of these studies are summarized. Studies of power producing hybrids, the use of fusion neutrons for transmutation of radioactive wastes, and the evaluation of the most likely combinations of fusion and fission technologies are discussed. (MOW)

3258 (ERDA-4, pp 173-208) MAJOR FEATURES OF A MIRROR FUSION–FAST FISSION HYBRID REACTOR. Moir, R. W.; Lee, J. D.; Burleigh, R. J. (Univ. of California, Livermore). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

A conceptual design was made of a fusion-fission reactor. The fusion component is a D-T plasma confined by a pair of magnetic mirror coils in a Yin-Yang configuration and sustained by hot neutral beam injection. The neutrons from the fusion plasma drive the fission assembly which is composed of natural uranium carbide fuel rods clad with stainless steel and is cooled by helium. It was shown how the reactor can be built using essentially present day construction technology and how the uranium bearing blanket modules can be routinely changed to allow separation of the bred fissile fuel of which approximately 1200 kg of plutonium are produced each year along with the approximately 750 MW of electricity. (auth)

3259 (ERDA-4, pp 209-220) RELEVANCE OF ENVIRONMENTAL CONCERNS IN CONTEMPLATING DEVELOPMENT OF FISSION FUSION HYBRIDS: A PERSONAL VIEW. Holdren, J. (Univ. of California, Berkeley). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

A brief comparison of hybrids to pure fusion systems with respect to timing and economics is given. The relevance of environmental concerns is discussed along with environmental criteria for hybrid designs. (MOW)

3260 (ERDA-4, pp 249-323) PROSPECTS FOR CONVERTING ^{232}Th TO ^{233}U IN A LINEAR THETA-PINCH HYBRID REACTOR (LTPHR). Krakowski, R. A.; Dudziak, D. J.; Oliphant, T. A.; Thomassen, K. I.; Bosler, G. E.; Ribe, F. L. (Los Alamos Scientific Lab., NM). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

The consequences of plasma end losses on the overall energy balance for a linear theta-pinch reactor can be ameliorated by use of a fission-enhanced, energy-multiplying blanket. This study is concerned with the constraints established by plasma physics, neutronics, energy balance, and economics on the design of a Linear Theta-Pinch Hybrid Reactor (LTPHR); although preliminary in nature, this study integrates these four important requirements in a consistent way. Although neutronically inferior to the ^{238}U/^{239}Pu fuel cycle, the ^{232}Th/^{233}U fuel cycle has been selected by this study on the basis of potential environmental advantages. Only present, well-understood technology for both the fission (HTGR) and fusion (Scylla) aspects of the LTPHR is evoked. On the basis of a generalized energy balance developed for the fusion-fission symbiosis, favorable energy multiplication (Q/sub E/ equals total electrical power/recirculated power approximately 5 to 10) results for theta-pinch systems which are below 1,000 m in length and self-sufficient for tritium. Although some ^{233}U-enrichment of the blanket is shown to be necessary, the optimum (minimum inventory for maximum energy multiplication) blanket configuration is yet to be evolved. An electrotechnology based on LC-resonant circuits is proposed, and reversible transfer of magnetic energy with efficiencies greater than 90 percent will be required. The mix between fission and fusion energy production is not specified. Preliminary cost estimates of major portions of the "nuclear island" (power supplies, switches, blanket, prorated fission burner) indicate costs in the range of 600 $/kWe for the highly (^{233}U) enriched systems. A major cost for the LTPHR (400-500 $/kWe) is associated with the capacitive power supply, and alternative magnetic energy storage schemes are explored. Typically, a 1,000-m-long LTPHR which has a 18 kg/m ^{233}U loading (non-optimized) gives an intrinsic doubling time of 11 y (0.79 tonnes/y ^{233}U production) for a first-wall, fusion neutron current of 2.0 MW/m^2. This system has a net tritium breeding gain, generates approximately 10 times its internal circulating power needs (for reversible transfer efficiency of 95 percent), and provides 7.38 MWe/m of electrical energy (12.8 MWe/m^3 of enriched seed or 2.44 kg-^{233}U/MWe) for a thermal conversion efficiency of 0.40; approximately 10 GJ of stored energy will be required, which must be switched at a frequency of 2 to 4 Hz to maintain a 1.0 MW/m^2 fusion-neutron wall loading. The design presented here in many ways is conservative, but these preliminary, favorable results warrant further exploration of the LTPHR concept. (auth)

3261 (ERDA-4, pp 327-357) ROLE OF A HYBRID (FUSION–FISSION) REACTOR IN A NUCLEAR ECONOMY. Wolkenhauer, W. C. (Washington Public Power Supply System, Richland, WA). 1974.

From meeting on fusion-driven fission systems; Germantown, Maryland, USA (3 Dec 1974).

In DCTR fusion–fission energy systems review meeting, December 3–4, 1974, Germantown, Maryland.

Some of the hybrid concepts which have been proposed to date are separated into groups according to their apparent neutronic characteristics. An attempt is made to identify these hybrid groups with two possible roles in a nuclear economy. An analysis is made to see if there is enough current information to determine which hybrid concepts appear most promising when assigned to these roles. (MOW)

3262 (ERDA-6) REPORT OF THE AD HOC PANEL ON CONFIGURATIONAL OPTIMIZATION AND IMPURITY CONTROL IN TOKAMAKS. (Energy Research and Development Administration, Washington, D. C. (USA)). Jun 1974. 77p. Dep. NTIS $5.45.

This report summarizes the present understanding on the subjects of configurational optimization and impurity control, explores the reactor implications of these questions and outlines the present experimental programs. Recommendations on the Doublet III and PDX proposals are presented along with general comments on the elements of comprehensive programs addressing the critical questions. (MOW)

3263 (IPP-4/120) FIRST TEST RESULTS OF THE SIEMENS PROTOTYPE SUPERCONDUCTING MAGNET W VII AT IPP. Kullmann, D.; Amenda, W.; Krueger, P.; Pillsticker, M. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Aug 1974. 17p. (In German). INIS.

The first test results with a big superconductive prototype coil developed for the Garching Stellarator W VII are reported. The main dimensions of the coil are: bore: 938 mm diam., winding cross section: 104 × 101.5 mm diam., inductance: 4.44 H. Flux jumping at low currents did not start quenching. The critical current of the Nb–Ti coil reaches 91% of the short sample value. The stored energy at quenching is 1.83 MJ and the maximum value of the magnetic field in the winding region is 61.5 kG. The mechanical stresses did not damage the windings. Degradation was not observed. A training of the coil was not necessary. Altogether the test was successful, as important technical problems were satisfactorily solved. Only parts of cryogenic systems should be improved in order to reduce the helium losses. (orig.)

3264 (IPP-4/126) CONSTRUCTION OF GAS SUSPENDED BEARINGS (GAS RADIALLY SUSPENDED AND GAS AXIALLY SUSPENDED). Kaspar, G. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Oct 1974. 27p. (In German). Dep. NTIS (US Sales Only) $4.50.

Practical and theoretical results that were obtained at IPP in the section of gas suspended bearings are presented. The two air-cushioned, air-driven revolving mirrors and an air-cushioned, air measuring coil drive were built. The latter has a double radial bearing and single axial bearing. The axial bearing is shaped in such a way that, with slight throttling of the air feed, i.e., at low air intake pressure, a relatively high bearing load can be imposed and the bearing remains at the same time free of the so-called air hammer effect. (auth)

3265 (UCID-16756) DT FUSION NEUTRON IRRADIATION OF LLL NIOBIUM TENSILE SPECIMEN, LASL-BNL SUPERCONDUCTOR WIRES, LLL MOLYBDENUM, VANADIUM AND ALUMINUM, LLL GRAPHITE, ORNL MAGNESIUM OXIDE CRYSTAL, SLL-LLL NATURAL QUARTZ, SYNTHETIC QUARTZ AND SUPRACIL, ANL ELECTRON MICROSCOPY SAMPLES, AND SLL FIBER OPTIC BUNDLES. MacLean, S. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1975. Contract W-7405-Eng-48. 20p. Dep. NTIS $4.00.

Samples of certain materials were irradiated using the LLL Rotating Target Neutron Source. The experimental specifics are given for each. No results are given. (MOW)

3266 (UCID-16765) HYPOTHESIS FOR THE MECHANISM OF NEGATIVE ION PRODUCTION IN THE SURFACE-PLASMA NEGATIVE HYDROGEN ION SOURCE. Hiskes, J. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Mar 1975. Contract W-7405-Eng-48. 19p. Dep. NTIS $4.00.

An analysis of the surface-plasma negative hydrogen ion source has shown that the tungsten cathode supports approximately a monolayer of cesium. The backscattering of protons from the cathode as energetic neutrals and the subsequent backscattering of these neutrals from the anode provides for a flux of energetic atoms incident upon the cathode which is comparable to the ion flux. A hypothesis is proposed for the generation of negative ions during the collision of these energetic atoms with the cathode. Several mechanisms for negative ion production by proton collision with the surface are discussed. (auth)

3267 (UCRL-75878) COMPUTER SIMULATIONS OF LASER DRIVEN IMPLOSION OF SEEDED HOLLOW PELLETS. Larsen, J. T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1974. 17p. (CONF-741079-9). Dep. NTIS $4.00.

From 16th annual meeting of the plasma physics division of the American Physical Society; Albuquerque, New Mexico, USA (28 Oct 1974).

The use of a hollow pellet of high r/DELTA r permits the successful generation of thermonuclear energy for a moderate laser input. Incorporation of a medium-z material is required for minimization of plasma instabilities and thus suppression of pathologically hot electrons. Designs of this nature are capable of giving yield ratios in excess of 20 for 100 kJ input. It is also likely that a lower-z material may be advantageous to minimize the x-rays radiation into the DT, but this will be at the sacrifice of using less laser power to remain below the plasma instability threshold. (auth)

3268 (UCRL-76253) MODEL CALCULATIONS AS ONE MEANS OF SATISFYING THE NEUTRON CROSS-SECTION REQUIREMENTS OF THE CTR PROGRAM. Gardner, D. G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Feb 1975. 36p. (CONF-750303-49). Dep. NTIS $5.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

A large amount of cross section and spectral information for neutron-induced reactions will be required for the CTR design program. To undertake to provide the required data through a purely experimental measurement program alone may not be the most efficient way of attacking the problem. It is suggested that a preliminary theoretical calculation be made of all relevant reactions on the dozen or so elements that now seem to comprise the inventory of possible construction materials to find out which are actually important, and over what energy ranges they are important. A number of computer codes for calculating cross sections for neutron induced reactions have been evaluated and extended. These will be described and examples will be given of various types of calculations of interest to the CTR program. (auth)

3269 (UCRL-76546) LASER FUSION: CAPITAL COST OF INERTIAL CONFINEMENT. Kidder, R. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Feb 1975. 5p. (CONF-741113-10). Dep. NTIS $4.00.

From international conference on energy storage, compression and switching; Turin, Italy (5 Nov 1974).

In the context of laser-induced fusion of solid pellets, a quadratic relation between peak laser power and the inertial confinement parameter rhoR is derived and discussed. This relation is combined with the linear relation between laser system cost and peak output power to obtain an estimate of the capital cost of inertial confinement. (auth)

3270 OBSERVATION OF NON-MAXWELLIAN ELECTRON DISTRIBUTION FUNCTIONS IN THE ALCATOR DEVICE BY MEANS OF THOMSON SCATTERING AND THEIR INTERPRETATION. Pieroni, L.; Segre, S.E. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. Lett. 34: No. 15, 928-930 (14 Apr 1975).

In the Alcator device incoherent Thomson scattering always gives Gaussian spectral profiles at low values of the ratio of electron drift velocity to thermal velocity ($v_D/v_{th} \lesssim 0.1$). However, at higher values of v_D/v_{th} non-Gaussian profiles are observed and can be interpreted in terms of scattering from electrons with high toroidal velocity (low-energy runaways). This interpretation is supported by soft-x-ray and plasma-resistivity measurements and agrees with a previous theoretical analysis. (auth)

3271 HOLLOW HYDROGEN SPHERES FOR LASER-FUSION TARGETS. Foster, C.A.; Hendricks, C.D.; Turnbull, R.J. (Charged Particle Research Laboratory, Department of Electrical Engineering, University of Illinois, Urbana, Illinois 61801). Appl. Phys. Lett. 26: No. 10, 580-581 (15 May 1975).

Many laser fusion experiments require the use of hollow spherical shells of hydrogen (deuterium-tritium mixture) as targets. We have produced hollow particles of normal hydrogen in preparation for producing shells of the various hydrogen isotopes and controlled mixtures of these isotopes. The hollow spheres were produced by ultrasonically nucleating bubbles in superheated liquid drops of hydrogen. Evaporation into the bubble increased its size and produced the shells. (auth)

3272 DESIGN OF AXISYMMETRIC PLASMA LENSES. Morozov, A.I.; Lebedev, S.V. Sov. Phys.–Tech. Phys. 19: No. 8, 996-1000 (Feb 1975).

The focusing properties of plasma lenses differ significantly from those of ordinary electromagnetic lenses in the additional focusing or defocusing by the electric fields arising from the space charge in the plasma beam in the lens. For a very low electron temperature ($T_e \to 0$) Laplace's equation ($\Delta\Phi = 0$) for the scalar electric potential is replaced by the equation $\Phi = \Phi(rA_\theta)$, where A_θ is the azimuthal component of the vector potential of the magnetic field. We discuss the focusing properties and methods of designing axisymmetric plasma lenses when $\Phi = \Phi(rA_\theta)$. We calculate focal lengths of plasma lenses for shaping beams close to the axis of symmetry and hollow cylindrical plasma beams. (auth)

3273 A HOMOGENEOUS LITHIUM-METAL CYLINDER FOR CTR-BLANKET EXPERIMENT. Cloth, P.; Filges, D.; Hammelmann, K. H.; Kirch, N. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Nucl. Instrum. Methods; 124: No. 1, 305-306(15 Feb 1975).

Design studies and construction techniques of a fusion reactor blanket model for nuclear measurements are described. (auth)

Wave Phenomena

Refer also to abstract 3245.

3274 (RT/FI-(74)50) ELECTROMAGNETIC SCATTERING BY INHOMOGENEOUS DIELECTRIC CYLINDERS IN RECTANGULAR WAVEGUIDE. Cicconi, G.; Rosatelli, C. (Comitato

Nazionale per l'Energia Nucleare, Rome (Italy)). Dec 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

Exact series solutions of the vector wave equation in circular cylindrical coordinates for homogeneous and inhomogeneous (Luneberg-type profile) dielectric cylinders are presented. These functions are used in order to calculate the reflection and transmission coefficients of dielectric posts (e.g., plasma column) in rectangular waveguide along with incident wave normally polarized with respect to cylinder axis. (auth)

3275 ENVELOPE SOLUTIONS FOR RANDOM-PHASE PLASMONS. Kaw, P.; Mima, K.; Nishikawa, K. (Faculty of Science, Hiroshima University, Hiroshima, Japan). Phys. Rev. Lett. 34: No. 13, 803-806 (31 Mar 1975).

We have carried out an investigation of coherent nonlinear envelope solutions for a spectrum of interacting random-phase electron plasma waves. Making a distinction between plasmons which are trapped or untrapped in density fluctuations associated with the envelope waves, it is shown that one can construct envelope solutions of arbitrary shape. (auth)

3276 MECHANISM FOR THE HARD–X-RAY EMISSION IN VACUUM SPARK DISCHARGES. Fukai, J.; Clothiaux, E.J. (Department of Physics, Auburn University, Auburn, Alabama 36830). Phys. Rev. Lett. 34: No. 14, 863-866 (7 Apr 1975).

A possible mechanism is discussed for the hard—x-ray emission observed in vacuum spark plasmas. The mechanism is based on the hypothesis that in the process of a sausage instability in a plasma pinch the plasma can have very high resistivity due to the constriction and strong turbulence, so that the conduction current is virtually cut off. In such a case strong electric fields should appear which could accelerate the electrons and ions to produce hard x rays as energetic as 20 times the discharge potential. The kinetic energies of ions and electrons are calculated. (auth)

3277 OBSERVATION OF PLASMA-DENSITY MODULATIONS PRODUCED BY RUBY-LASER LIGHT MIXING. Albach, G.G.; Meyer, J. (Department of Physics, The University of British Columbia, Vancouver, British Columbia, Canada). Phys. Rev. Lett. 34: No. 15, 926-928 (14 Apr 1975).

The effect of mixing two high-power ruby-laser beams in a plasma has been investigated by means of light scattering. Coherently scattered light has been observed with intensities of up to 30 times that scattered by incoherent thermal fluctuations. As indicated by the wave-vector distribution, the nonlinear electromotive forces of the mixed electromagnetic waves produce a stationary electron-density wave in the plasma. (auth)

3278 SPATIAL EVOLUTION OF VELOCITY-MODULATED ION BEAMS IN A PLASMA. Sato, N.; Sugai, H.; Hatakeyama, R. (Department of Electronic Engineering, Tohoku University, Sendai, Japan). Phys. Rev. Lett. 34: No. 15, 931-934 (14 Apr 1975).

Spatial growth and damping of a velocity-modulated ion beam are observed in a *Q* machine where no ion-ion instability is predicted. The phenomena are well explained by linear "wave" theory for beam bunching. (auth)

3279 ELECTROMAGNETIC WAVE PROPAGATION IN A MOVING MAGNETOPLASMA MEDIUM IN THE PRESENCE OF A BOUNDARY. Mukherjee, P.K. (Department of Physics and Astrophysics, University of Delhi, Delhi-110007, India). J. Appl. Phys. 46: No. 5, 2295-2297 (May 1975).

Some specific features of electromagnetic wave propagation in a moving magnetoplasma, bounded by a plane, are studied. Expressions are obtained for the modified Snell's law of refraction, the critical angle for total reflection, the refractive indices, and the phase and the group velocities of the waves supported by the moving medium. Analytic conditions for the total reflection of *H*-polarized incident wave (with the electric vector in the plane of incidence) are also discussed. (auth)

3280 THEORY AND SIMULATION OF RESONANT ABSORPTION IN A HOT PLASMA. Forslund, D. W. (Los Alamos Scientific Lab., NM); Kindel, J. M.; Lee, K.; Lindman, E. L.; Morse, R. L. Phys. Rev., A; 11: No. 2, 679-683(Feb 1975).

A detailed theoretical and simulation study of resonant absorption in a hot plasma is presented which isolates the behavior of the plasma for times short compared to an ion response time. The extent to which an electron fluid model can describe the absorption process in the kinetic regime is discussed. At high intensities the absorbed energy is observed to be deposited in a suprathermal tail of electrons whose energy varies approximately as the square root of the incident power. The density profile modification due to the ion response to the ponderomotive force is also discussed. (auth)

3281 PRODUCTION OF HARD X RAYS IN A PLASMA FOCUS. Newman, C.E. (Institute for Plasma Research, Stanford University, Stanford, California 94305); Petrosian, V. Phys. Fluids 18: No. 5, 547-551 (May 1975).

A model of the plasma focus is considered, in which large axial electric fields are induced by the imploding current sheet during the final few nanoseconds of the collapse phase. This field provides a mechanism for creation of a beam of electrons of highly suprathermal energies. For such a beam, having a power-law energy spectrum, the bremsstrahlung radiation above 100 keV to be expected from it, both from electron-deuteron collisions in the focused plasma itself and when the beam reaches the walls of the device, is calculated. The expected radiation from the walls is found to be several orders of magnitude higher than that from the plasma. Thus, since experimental evidence indicates that little or no radiation above 100 keV originates in the walls, the conclusion is drawn that the electrons in the beam must be decelerated after leaving the plasma and before reaching the walls. Upon comparison with experimental results, qualitative agreement of the expected angular distribution of hard x rays with experiment is found. The total energy in accelerated electrons required to produce the observed total energy in hard x rays by this mechanism is also reasonable when compared with the total energy of the device. (auth)

3282 POWER SPECTRUM OF POTENTIAL FLUCTUATIONS IN A MOVING MAGNETOACTIVE PLASMA. Kostin, V.M. (Institute of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Academy of Sciences of the USSR, Moscow). Sov. Phys.–Tech. Phys. 19: No. 8, 1053-1056 (Feb 1975).

The thermal fluctuations of the potential between two moving points in a plasma are studied. The singularities of the power spectrum at the lower and upper hybrid frequencies are analyzed in detail. (auth)

3283 SCATTERING OF AN ELECTRON BEAM IN A STRAIGHT *dc* TURBULENT PLASMA. Golovanov, Yu.P.; Zakatov, L.P.; Kingsep, A.S.; Plakhov, A.G. Sov. Phys.–Tech. Phys. 19: No. 8, 1046-1049 (Feb 1975).

A sharp reduction is observed in the current density of an external electron beam that moves through a turbulent straight dc discharge. It is established that the reduction in beam current density is correlated with radiation at twice the plasma frequency and with x-ray radiation bursts. The sharp reduction in current density is due to scattering of beam electrons by turbulent plasma fluctuations in localized regions. On the basis of theoretical estimates and controlled experiments the electron scattering is related to fluctuations associated with electron plasma oscillations. (auth)

3284 ELECTROSTATIC WAVES NEAR THE ELECTRON CYCLOTRON HARMONICS. Bagliani, M.; Fontanesi, M.; Ramponi, G. (Univ., Milan). Nuovo Cim., 26B: No. 1, 31-46(11 Mar 1975).

Electron cyclotron harmonic waves are investigated in an argon plasma column with axial magnetic field. Two coaxial T-shaped probes are used to launch and to detect the waves. By amplitude and phase radial measurements of the rf signal in the plasma, the wavelengths, the direction of the phase velocity, and the region where the waves are generated are determined. The results are limited to backward waves. Electron-neutral collision frequency effects on the amplitude of these waves have been also pointed out. (auth)

3285 EFFECT OF COLLISIONAL MODELS ON THE DISPERSION PROPERTIES OF ELECTROMAGNETIC WAVES. Gupta, G. P.; Singh, R. N. (Banaras Hindu Univ., Varanasi, India). Nuovo Cim., 26: No. 1, 57-66(11 Mar 1975).

Following the Van Kampen technique, the dispersion equations for high-frequency electromagnetic waves were derived for two collisional models. The indices of refraction and absorption were computed. It is shown that the maximum change in the dispersion feature results in the vicinity of $\omega_p^2/\omega^2 = 1$. (auth)

3286 SPECIAL SOLUTIONS FOR NONLINEAR WAVE-PARTICLE INTERACTION. Ying Fun Chu, F. (Wisconsin Univ., Madison (USA). Dept. of Electrical Engineering). Phys. Lett., A; 51: No. 3, 129-130(24 Feb 1975).

A class of exact solutions for a coupled set of nonlinear equations describing the interaction between two propagating waves and a system of particles is found. These solutions include travelling wave solutions of the nonlinear coupled equations. (auth)

3287 EVOLUTION OF DAMPED CYCLOTRON HARMONIC WAVES VERSUS THE ANGLE OF PROPAGATION. Meyer, R. L. (Nancy-1 Univ., 54 (France). Lab. de Physique des Milieux Ionises). Phys. Lett., A; 51: No. 4, 239-240(10 Mar 1975).

The author computes the evolution of cyclotron harmonic waves from orthogonal to quasi-parallel propagation with respect to the magnetic field and recovers the longitudinal waves. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 4010.

3288 (AD/A-002218) HEAT TRANSFER DESIGN AND PROOF TESTS OF A RADIOISOTOPE THERMOELECTRIC GENERATOR. Final Report, November 1972–July 1974. Beck, E. J. (Naval Civil Engineering Lab., Port Hueneme, Calif. (USA)). Nov 1974. 51p. (CEL-TN-1359). NTIS $4.25.

The object was to design, build, and test the heat rejection portions of a large 2-kW(e) radioisotope thermoelectric generator (RTG). The design was optimized to produce the lowest practicable temperatures at the cold junction of a large number of thermoelectric heat-to-electricity conversion elements. The geometry was largely defined by the size, shape, and required number of thermoelectric elements and by their deployment at the upper end of a large pressure-resistant hull. The work showed the capability of the 12-finned convectors to maintain a temperature below 90°F, at the inner face of the convectors both when the unit was vertical and when tilted 60 degrees from the vertical. The solid copper showed no signs of corrosion; the potential corrosion problem is discussed in some detail in the report, as are related problems of flow, protection, and possible fouling from marine growth. (GRA)

3289 (SC-PR-69-237) SPACE ISOTOPE POWER PROGRAM. Quarterly Report, January–March 1969. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1969. 39p. Dep. NTIS $5.00.

Declassified 2 Nov 1971.

Progress during the period from January to April 1969 in the development of radioisotope thermoelectric generators for the SNAP-19, -27, -29, and Transit programs is reported. (LCL)

3290 (SC-PR-70-235) SPACE ISOTOPE POWER PROGRAM. Quarterly Report, January–March 1970. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1970. 46p. Dep. NTIS $5.50.

Declassified 2 Nov 1971.

Progress during the period from Jan. to April 1970 in the development of SNAP-19, SNAP-27, and Transit radioisotope thermoelectric power systems for space use is reported. (LCL)

Facilities and Equipment

Refer also to abstracts 3436 and 4183.

3291 (BNWL-tr-141) INCREASING THE HEAT-TRANSFER EFFICIENCY IN THIN-FILM EVAPORATORS. Godau, H. J. Translated from Chem. Tech. (Leipzig); 24: No. 10, 609-613(Oct 1972). 15p. Dep. NTIS $4.00.

The investigations demonstrated that the efficiency of thin-film evaporators can be increased substantially if the physical processes transpiring in the apparatus are taken into consideration. In doing this, the different types of flows must be considered. For viscous media, the efficiency depends on the rotation speed only up to a certain point. The heat transfer can be increased considerably by varying the gap between rotor and stator as well as by varying the number of rotor blades. By adjusting the apparatus to the technique, there are many ways for the operator to affect the efficiency of thin-film evaporators and to make the process economical. (auth)

3292 (NTO-A-0040(Sec. 008.)(Rev. 1)) NERVA TEST OPERATIONS EMERGENCY PLAN E-MAD COMPLEX. Wayne, W. D. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 22 Jan 1968. 19p. Dep. NTIS $4.00.

Procedures for immediate response and follow-up action for personnel at the E-MAD Complex during emergency conditions are established. The following conditions at the E-MAD Facility may require enactment of emergency procedures and/or evacuation of personnel: an accidental criticality; a large fire; uncontrolled radiation exposure; uncontrolled release of radioactive particulate; unknown and undefined conditions which may pose a threat to life or property; and civil disturbances, national emergencies and localized emergencies as defined by the Chief, SNPO-N. (auth)

3293 (NTO-I-0078) TEST DESCRIPTION FOR EXPERIMENTAL PLAN V STEAM GENERATOR DEVELOPMENT TEST PROGRAM. Henze, H. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 23 Feb 1966. 17p. Dep. NTIS $4.00.

Plans are presented for performance testing of the steam generator system at Engine Test Stand-1, NERVA Test Operations. (LCL)

3294 (NTO-I-0129) TEST DESCRIPTION FOR FACILITY EXPERIMENTAL PLAN I, LN_2 COOLDOWN FLOW TESTS. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 25 Aug 1966. 20p. Dep. NTIS $4.00.

The LN_2 Cooldown System is to provide liquid nitrogen to the NERVA engine at the required flow rates following engine test runs in order to accomplish the required cooldown of the test article. An experimental plan as the first subsystem checkout is described and will be used to prove the construction and operation of the liquid nitrogen cooldown system and its components. (auth)

3295 (NTO-M-16846) TEST PREDICTION REPORT FOR ETC HELIUM(PCV-449) PURGE SYSTEM CHECKOUT. Maxon, B. S. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 11 Sep 1967. 16p. Dep. NTIS $4.00.

The equipment and method to be used to check the performance of the ETC Helium Purge System are described, and test results are presented. This purge system prevents air back flow into the nuclear exhaust system duct in the event of loss of steam flow during engine testing. (LCL)

3296 (NTO-M-18986) NEP-N-I SPEAR RECOMMENDATIONS ASSIGNMENT FOR NTO RESOLUTION. Wayne, W. D. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 21 Nov 1967. 37p. Dep. NTIS $5.00.

Recommendations are made for improving the performance of equipment used for testing NERVA engines. The operation of the H_2/O_2 system and the capability of the H_2/O_2 analyzer system to function at operating pressures are discussed. (LCL)

3297 (NTO-M-21848) NTO SEMI-MONTHLY PROGRESS REPORT FOR THE PERIOD OF FEBRUARY 1–15, 1968. Wayne, W. D. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 1 Mar 1968. 25p. Dep. NTIS $4.25.

Progress during the period from Feb. 1 to 15, 1968 in the operation of NERVA test and maintenance facilities is reported. (LCL)

3298 (NTO-M-21874) SECOND QUARTERLY PROGRESS REPORT INPUT TO WANL FOR CY 1968. Wayne, W. D. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 28 Mar 1968. 66p. Dep. NTIS $6.50.

NERVA reactor testing information is included on ground operation safety, including radiation and criticality safety; product assurance; coordination of NRDS organizations; test cell "C" operations; testing plans; engine test operations; and data evaluation. (LCL)

3299 (NTO-R-0012) NTO TEST REPORT FOR ENGINE TEST COMPARTMENT: MECHANICAL, SEAL AND LEAK TEST, ETC EP-I. Endo, J. K.; Huntsman, L. K. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 17 Jun 1967. 81p. Dep. NTIS $7.25.

The Engine Test Compartment (ETC) at NERVA ETS-1 was tested from April 19 through 28, 1967. The test program was performed to demonstrate that the ETC meets the design, functional, operational and safety requirements for the planned engine test operation. The test program was conducted under the following four major sections: ETC makeup and mechanical seal tests; ETC leak tests; ETC off-normal tests; and shield water flow tests. (auth)

3300 (NTO-R-0139) SPEAR TEAM REPORT, NEP-HE-1, NEP-HE-2. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 14 Mar 1968. 155p. Dep. NTIS $10.75.

Two tests are described that were conducted on March 1 and 8, 1968 to demonstrate the helium system designed to prevent air ingestion into the NERVA Nuclear Exhaust System (NES) duct and engine compartment in the event of a steam generator malfunction. Information is included on the prevention of air backflow during generator malfunction; performance of steam pressure loss detectors; steam generator operation; duct water flow; engine and ETC integrity during He flow; and He performance of systems for sealing, data acquisition and processing; nitrogen purging, and steam piping. (LCL)

3301 (TID/SNA-1511) NERVA FACILITY SEISMIC DESIGN STANDARDS. (Blume (John A.) and Associates, Engineers, San Francisco, Calif. (USA)). Aug 1970. 60p. Dep. NTIS $6.00.

This STANDARD prescribes criteria and furnishes guidance for the seismic analysis and design of Space Nuclear Propulsion

Office facilities. The criteria of this STANDARD apply to buildings, structures, equipment, piping, and exterior utility systems. It is intended that this STANDARD be used in the planning, design, and construction of seismic-resistant facilities for possible seismic activity resulting from either underground nuclear events or earthquakes. (auth)

3302 (TID/SNA-1653) NERVA E-MAD REMOTE HANDLING SYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Jun 1964. 24p. Dep. NTIS $4.25.

The E-MAD Remote Handling System which is composed of the overhead positioning subsystem, the wall-mounted handling subsystem, and the floor handling subsystem is described. (LCL)

3303 (TID/SNA-1672(Vol. 3)) INSTRUMENTATION AND CONTROL SYSTEM DESIGN CRITERIA. Test Cell ETS-1 NNRDC. Volume III. Criteria Technical Data Sheets (Equipment). (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Jun 1962. 283p. Dep. NTIS $17.25.

Criteria technical data sheets are given for the following: instrument and control system; remote engine control system; facility operations and control systems; data acquisition system (electronic); and data acquisition system (photographic). (TFD)

3304 (UCID-16761) STRESS ANALYSIS OF A RUPTURE DISK. Werne, R. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1975. Contract W-7405-Eng-48. 25p. Dep. NTIS $4.25.

The results of an elastic stress analysis of the rupture disk for an internal pressure of 45.5 MPa (6600 psi) indicate that the maximum von Mises stresses occur in the membrane and are on the order of 483 to 690 MPa (70,000 psi). This far exceeds the yield of the membrane material of 207 MPa (30,000 psi). These high stresses are expected since the membrane is designed to burst at that design pressure. The von Mises stresses in the rest of the body are less than 138 MPa (20,000 psi). An elastic-plastic analysis of the membrane alone subjected to the 45.5 MPa (6600 psi) pressure indicates that it becomes plastically unstable, i.e., it continues to deform under constant load. A second load case with a constant 6.9 MPa (1000 psi) pressure throughout the entire body (i.e., after release of pressure by burst of the membrane) was analyzed. The results indicate that the elastic von Mises stresses are less than 26.7 MPa (3880 psi) throughout the body. (auth)

3305 (WANL-TMI-1861) STEM THREAD SEALING TESTS, RD: TS:36. Thomson, J. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Dec 1967. 7p. Dep. NTIS $4.00.

Tests were performed to determine if silastic RTV 891 sealant would perform as an effective pressure seal on the threads of the NERVA Reactor-1 cluster assembly. Eight specimens were tested in a helium atmosphere to provide data on leak rates versus pressure at ambient temperature and at 140°R. Two of the 8 specimens did leak. (LCL)

3306 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Wolff, P. H. W. (to British Nuclear Design and Construction Ltd.). British Patent 1,376,330/B/. 4 Dec 1974. Filed Date 29 Dec 1971. 6p.

Reference is made to heat exchangers suitable for use as intermediate exchangers in Na-cooled nuclear reactors. Disadvantages of conventional heat exchangers consisting of simple tube-in-shell arrangements, welded into header plates, are stated, and an improved type is claimed consisting of helical tubes arranged to lie in coaxial cylindrical layers. By the use of helical tubes the surface area required for heat transfer can be obtained with fewer tubes of greater length and diameter than is economic with straight tube-in-shell exchangers. The reduction in the number of tubes allows reduction of the area of header plates, and this is beneficial in reducing thermal stresses in tubes and header plates due to rapid temperature changes. Full constructional details are given. (UK)

3307 INTERFEROMETRIC TUNING OF A 15-ATM CO_2 LASER. O'Neill, F.; Whitney, W. T. (Naval Research Lab., Washington, DC). Appl. Phys. Lett.; 26: No. 8, 454-456(15 Apr 1975).

Efficient controlled frequency narrowing and tuning of a high-power 15-atm electron-beam-controlled CO_2 laser were achieved using a Fabry-Perot etalon as a dispersive element in the laser resonator. Tuning was accomplished over the free spectral range of the etalon (approximately 2.3 cm^{-1}) giving a laser linewidth of less than 0.2 cm^{-1} for an output pulse energy approximately 100 mJ in a spot size approximately 1 mm^2. The laser pulse length is approximately 40 nsec for a peak power approximately 5 MW. (auth)

3308 REVIEW OF CONTINUUM, FINITE ELEMENT, AND HYBRID TECHNIQUES IN THE ANALYSIS OF STRESS CONCENTRATIONS IN STRUCTURES. Rao, A. K. (Indian Inst. of Science, Bangalore). Nucl. Eng. Des.; 31: No. 3, 427-433(1974).

Exact mathematical analysis of stress concentrations in finite bodies presents considerable difficulty for all but a few problems of infinite fields, concentric annuli and the like, treated under the presumption of small deformation, linear elasticity. A whole series of techniques have been developed to deal with different classes of shapes and domains, causes and sources of concentration, material behavior, phenomenological formulation, etc. These include real and complex functions, conformal mapping, transform techniques, integral equations, finite differences and relaxation, and, more recently, the finite element methods. With the advent of large high speed computers, development of finite element concepts and a good understanding of functional analysis, it is now, in principle, possible to obtain with economy satisfactory solutions to a whole range of concentration problems by intelligently combining theory and computer application. An example is the hybridization of continuum concepts with computer based finite element formulations. This new situation also makes possible a more direct approach to the problem of design which is the primary purpose of most engineering analyses. The trend would appear to be clear: the computer will shape the theory, analysis and design. (auth)

3309 DERIVATION OF VARIOUS NON-HOMOGENEOUS ANISOTROPIC SHELL THEORIES APPLICABLE IN PRESSURE VESSEL DESIGN. Widera, O. E. (Illinois Univ., Chicago (USA)); Chung, S W. (Graver Tank and Manufacturing Company, East Chicago, Indiana, USA). Nucl. Eng. Des.; 31: No. 3, 405-426 (1974).

While many shell theories and solutions are available to the designer for conventional pressure-vessel analysis, relatively little work exists for composite material vessels. Such vessels are in general constructed of thin layers consisting of filaments (reinforcing fibers) and matrix materials which may have different thicknesses and different fiber arrangements. Because of this construction, composite vessels must be analyzed according to theories which allow for nonhomogeneous, anisotropic material behavior. These theories are, however, difficult to derive by means of the classical method. A way of departing from the classical assumptions is to apply the method of asymptotic integration of the three-dimensional elasticity equations. This method has, as its foundation, the desire to obtain rational two-dimensional theories which are approximately valid when a problem parameter is very small. (auth)

Lasers

3310 (AD-780788) SPECTROSCOPIC ANALYSIS OF AZIDE DECOMPOSITION PRODUCTS FOR USE IN A PYROTECHNICALLY INITIATED CARBON DIOXIDE CHEMICAL LASER. Dinerman, C. E. (Naval Ammunition Depot, Crane, Ind., (USA)). 10 May 1974. 23p. NTIS $3.00.

In the consideration of sodium azide as a potential nitrogen source for a nitrogen-carbon dioxide chemical laser, it is important to know the fraction of the heat of decomposition of the azide that will appear as vibrational excitation in the nitrogen. To this end, the progressions of the Lyman-Birge-Hopfield bands of nitrogen were monitored by means of absorption spectroscopy in the vacuum ultraviolet, upon thermal decomposition of sodium azide. The experimental system is described and results to date are discussed. (auth)

3311 (AD-787497) OPTICALLY PUMPED LASER. Semi-annual Technical Report, 1 March-15 August 1974. Brown, R. T. (United Aircraft Research Labs., East Hartford, Conn. (USA)). 10 Oct 1974. Contract N00014-74-C-0376. 63p. (UARL-N-921853-2). NTIS $4.25.

The report describes experimental and theoretical studies of a new technique for pumping high-pressure electric-discharge lasers. Diffuse discharges in mixtures of He/N_2 and $He/N_2/Ar$ at electron densities in excess of 10×10^{15}/cc and pressures of 15 atm were obtained. Calculations for a He/Xe mixture operating on the 1730Å transition in molecular Xe show efficiencies for conversion from the 10.6 micrometer field into the uv radiation field in excess of 60%. Kinetic studies of the excimer energy transfer in $He/Ar/N_2$ mixtures are described along with new pumping configurations which will allow operation with a uv optical cavity. (auth)

3312 (AD/A-002223) HIGH-POWER CO LASER. Quarterly Technical Report, 1 June-31 September 1974. Draggoo, V. G.; Lacina, W. B.; McAllister, G. L. (Northrop Research and Technology Center, Hawthorne, Calif. (USA)). Nov 1974. Contract N00014-72-C-0043. 44p. (NRTC-74-56R). NTIS $3.75.

Effort on the high power CO laser program is reviewed. The program is directed toward the development of the required CO laser technology, the required component technology, and the design and construction of intermediate power laser devices. The results of analytical and experimental investigation of the basic characteristics of the laser and data from a high pressure electrically excited CO laser device are discussed. (GRA)

3313 (AD/A-002309) PHOTOCHEMICAL STUDIES ON ORGANIC LASERS. Final Report, 1 February 1973–31 January 1974. Srinivasan, R.; Von Gutfeld, R. J.; Angadiyavar, C. S.; Tynan, E. E. (IBM Watson Research Center, Yorktown Heights, N. Y. (USA)). Jun 1974. 26p. NTIS $3.75.

The fluorescence emission from alcoholic solutions of 7-monoalkyl-amino-4-methyl coumarins shifts from blue to blue-green on the addition of acid. Fluorescence and excitation spectra measured, and lasing species are discussed. New laser dyes based on the coumarin skeleton have been synthesized by varying the substituent groups at the 3- and 7-positions. 7-amino-coumarins which were partially or totally alkylated were efficient lasers. The presence of a benzthiazole group at the 3- position shifted the laser emission to the green region. New laser dyes of the pyridine class were also synthesized. These were effective in the violet region of the spectrum. (GRA)

3314 (AD/A-002441) RAPID ACOUSTOOPTIC TUNING OF A DYE LASER. Hutcheson, L. D.; Hughes, R. S. (Naval Weapons Center, China Lake, Calif. (USA)). Nov 1974. 28p. NTIS $3.75.

Rapid tuning of a dye laser over a large wavelength range has been achieved by inserting an acoustooptic deflector between the dye cell and a diffraction grating. The deflector and grating combination serve as the tuning element. TeO_2, which has an anomalously low sound velocity, has been used to demonstrate acoustooptical tuning over a broad spectral range. Theoretically, tuning rates greater than 100 nm/μs can be achieved over a wavelength range of up to 35 nm. The experimental data have been used to verify the analytical aspects of the beam deflector and diffraction grating configuration. (GRA)

3315 (AFWL-TR-73-187) CONCEPTUAL DESIGN STUDIES OF CO ELECTRIC DISCHARGE LASER SYSTEMS. Final Report, 27 November 1972–27 June 1973. Eckbreth, A. C. (United Aircraft Research Labs., East Hartford, Conn. (USA)). Jan 1974. Contract F29601-73-C-0027. 300p. NTIS.

An analytical investigation was performed to formulate and evaluate a minimum of six conceptual designs of cw, open-cycle, CO electric-discharge (EDL) systems for laboratory use. Kinetic-optical analyses were performed employing a computer model of CO EDL behavior whose predictions are in good agreement with experimentally reported gain and power spectra. The performance of CO EDLs which involve both spatially coincident and distinct discharge/cavity regions was examined. The behavior of these devices was found to depend primarily on gas translational temperature and can be understood in terms of a threshold excitation energy. Of the many cooling techniques investigated, three appear most attractive for a laboratory CO EDL; namely: (1) aerodynamic expansion to supersonic flow, (2) heat exchange with liquid N_2 sink for CO lasers using a He diluent, and (3) direct evaporation of cryogenically stored Ar for systems employing Ar as the diluent. The six most promising CO EDL systems, which have undergone conceptual design, include three coincident and three distinct discharge/cavity configurations. Of the former class, the devices employ (1) supersonic flow with either He or Ar diluents, (2) subsonic flow with He diluent and N_2 heat exchange, and (3) subsonic flow with evaporation of cryogenically stored Ar. Of the latter type, the configurations use (4) supersonic expansion of a CO mixture vibrationally excited in a high-pressure, subsonic plenum, (5) mixing of cold CO into a cryogenically cold subsonic stream of vibrationally excited N_2, and (6) mixing of CO into a "room" temperature stream of vibrationally excited N_2 followed by expansion to supersonic Mach numbers. Based upon evaluation criteria furnished by AFWL for rating the specific 20 kW laboratory CO EDL designs, the subsonic coincident configurations rate highest due to their superior parametric flexibility for 20 kW laboratory investigations. (auth)

3316 (IPP-4/121) $TEACO_2$ OSCILLATORS FOR THE GENERATION OF 1 NS-PULSES IN SINGLE AND MULTILINE AND TWO-BAND OPERATION. Baumhacker, H.; Brinkschulte, H.; Fill, E.; Lang, R. S. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Aug 1974. 48p. (In German). INIS.

Several TEA CO_2 oscillators which produce short single pulses of about 1.2 ns duration are described. The energy of one short pulse is 20-30 mJ, which corresponds to a power of 17-25 MW. The beam divergence is 1.6-2 mrad and therefore nearly diffraction-limited. The short pulses are generated both actively by acousto-optic-mode-locking techniques, and passively by mode-locking by means of nonlinear absorbers. By inserting spectrally selective absorbers in the resonator and using a spectrally controlled pilot oscillator it is possible to achieve multiline oscillations on the P- and R-branches of the 10.4 μm and/or 9.4 μm band. (orig.)

3317 (LA-5812) RICE: A COMPUTER PROGRAM FOR MULTICOMPONENT CHEMICALLY REACTIVE FLOWS AT ALL SPEEDS. Rivard, W. C.; Farmer, O. A.; Butler, T. D. (Los Alamos Scientific Lab., N. Mex. (USA)). Nov 1974. Contract W-7405-eng-36. 136p. Dep. NTIS $5.45.

The fluid dynamics of chemically reactive mixtures are calculated at arbitrary flow speeds with the RICE program. The dynamics are governed by the two-dimensional, time-dependent Navier-Stokes equations together with the species transport equations and the mass-action rate equations for the chemical reactions. The mass and momentum equations for the mixture are solved implicitly by the ICE technique. The equations for total energy and species transport are solved explicitly while the chemical rate equations are solved implicitly with a time step that may be a submultiple of the hydrodynamic time step. Application is made to continuous wave HF chemical lasers to compute the supersonic mixing and chemical reactions that take place in the lasing cavity. (auth)

3318 (LA-UR-75-389) DISPERSIVE TEMPORAL COMPRESSION OF THE ENERGY IN LASER PULSES: A REVIEW. Fisher, R. A. (Los Alamos Scientific Lab., N. Mex. (USA)). 1975. Contract W-7405-eng-36. 6p. (CONF-741113-9). Dep. NTIS $4.00.

From international conference on energy storage, compression and switching; Turin, Italy (5 Nov 1974).

Analagous to chirp radar compression schemes, the dispersive temporal compression of "chirped" light pulses has been discussed for many years now. Development of these optical pulse compression techniques is reviewed. This scheme can provide pulses so short that they would otherwise be unavailable, and such a scheme has the potential for improving the efficiency of short-pulse laser amplifier chains. (auth)

3319 (SAND-74-0425) XENON OXIDE FORMATION AND DESTRUCTION IN HIGH PRESSURE MIXTURES EXCITED BY HIGH ENERGY ELECTRON BEAMS. Tisone, G. C.; Hoffman, J. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 52p. Dep. NTIS $5.75.

The radiation produced by electron-beam excitation of high-pressure mixtures of xenon and oxygen-donor molecules has been investigated. The radiation which was observed resulted from either bound-bound or bound-free transitions in the XeO molecule. The late-time decay rate as a function of Xe pressure has been determined. The radiative lifetime of the v' equals 0 level of the 2^1SIGMA^+ state was estimated by using a simple model to describe the production and destruction of the XeO molecules. From this model a radiative lifetime between $.39 \times 10^{-6}$ sec to 1.2×10^{-6} sec for this state is inferred. The results of cooling the mixture and of adding nitrogen to the mixture are discussed. Finally, attempts to produce laser action with this molecule are described. (auth)

3320 (UCRL-Trans-10832) CALCULATIONS OF LASER-EMISSION PARAMETERS IN MOLECULAR NITROGEN. Girardeau-Montaut, J. P.; Girardeau-Montaut, C. Translated from Nouv. Rev. Opt.; 5: No. 3, 179-183(1974). 39p. Dep. NTIS $5.00.

The purpose of the calculations carried out was to determine the variation of the main emission parameters of an ultraviolet molecular-gas laser with pulsed electronic pumping. In particular, they make it possible to analyze the time variations of the electron energy and density in the gas, the resistance of the plasma created during the pumping, the population inversion rate and the laser power density for given operating conditions (applied electric field and gas pressure). These calculations, worked out for the case of the transitions from the 2nd positive band $C^3\Pi u \rightarrow B^3\Pi g$ of N_2, can easily be extended to other molecular gases having analogous population-inversion schemes. They can be used to evaluate the probability of new short-wavelength laser emissions and the optimal operating conditions. (auth)

3321 EFFICIENT POLARIZATION OF LASER RADIATION BY A PRISM WITH SMALL BIREFRINGENCE. Nestrizhenko, Yu. A.; Dalchenko, O. G.; Pyatikop, A. P.; Shevchenko, V. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 36: No. 3, 321-323(Mar 1974).

Translated from Opt. Spectrosk.; 36: No. 3, 557-560(Mar 1974).

With total internal reflection (TIR) for a beam of one polarization, the beam of another polarization is partially reflected. An experimental investigation is described to explain the maximum

reflectance of the suppressed polarization component at which lasing of linearly polarized light is still possible. It is concluded that TIR polarizers with $\Delta n \sim 10^{-4}$ (e.g., barium strontium niobate in a moderate electric field) can be used as an electrooptic shutter. (Elect. Electron. Abstr.)

3322 NEAR-THRESHOLD RUBY LASER UNDER PASSIVE Q-SWITCHING. Bogdaov, V. L.; Klochkov, V. P. Opt. Spectrosc. (USSR) (Engl. Transl.); 36: No. 2, 233-235(Feb 1974).

Translated from Opt. Spectrosk.; 36: No. 2, 405-409(Feb 1974).

An experimental study of the structure of the giant pulse due to Q-switching of a ruby laser by dye vapor is reported. Degree of proximity to threshold was altered by adjustment of ruby temperature. Lasing energy is plotted as a function of temperature for different switch optical densities. At high densities divergence increases appreciably with temperature as indicated by plots of near and far field distributions. Results are discussed in detail. (Elect. Electron. Abstr.)

3323 FURTHER EVIDENCE OF DIMER EMISSION FROM SUPERRADIANT TRAVELLING WAVE LASER OF CONCENTRATED AQUEOUS SOLUTION OF RHODAMINE 6G AND B. Chin, S. L. (Univ. of Laval, Quebec). Phys. Lett.; 48A: No. 6, 403-404(29 Jul 1974).

The new emission bands of the superradiant travelling-wave lasers from concentrated aqueous rhodamine B and rhodamine 6G were quenched by the addition of a small amount of triton X-100. This further supports the hypothesis that the new emission band could be due to the dimers of the dyes. (Elect. Electron. Abstr.)

3324 LOW FREQUENCY BEATS IN THE EMISSION OF A CW ARGON LASER IN A MAGNETIC FIELD. Fotiadi, A. E.; Fridrikhov, S. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 36: No. 2, 247-248(Feb 1974).

Translated from Opt. Spectrosk.; 36: No. 2, 430-432(Feb 1974).

Variation of the frequency f with longitudinal and transverse fields, with discharge current and with laser intensity was studied experimentally for fields up to 1500 Oe and 450 Oe, respectively. Curves are given which show approximately linear increase of f with intensity for varying field strength. Curves of f for varying laser intensity are also given. It is also confirmed that low-frequency beats are absent in single-mode lasing with central detuning. (Elect. Electron. Abstr.)

3325 ACTIVE MODE SELECTION IN CO_2-TEA LASERS WITH HELICOIDAL CONFIGURATION OF ELECTRODES. Verreault, M.; Otis, G.; Tremblay, R. (Univ. of Laval, Que.). Opt. Commun.; 11: No. 3, 227-230(Jul 1974).

By selective excitation, specific transverse modes such as the "doughnut" mode, can readily be generated from helical CO_2-TEA (TEA-H) lasers. Experimental investigations on the active laser mode selection are reported. (Elect. Electron. Abstr.)

3326 DOUBLY-CONFOCAL UNSTABLE RING RESONATOR. Dal Pozzo, P.; Polloni, R.; Svelto, O.; Zaraga, F. (CNR, Milan). Opt. Commun.; 11: No. 2, 115-117(Jun 1974).

An unstable ring resonator made by two positive lenses having their two foci in common is discussed and studied. This laser yields quasi-travelling-wave operation with a very high ratio of the powers of the two opposite rotating waves (about 400), and is suitable for mode-locking or Q-switching. (Elect. Electron. Abstr.)

3327 SIMPLE LOW-DIVERGENCE H_2 LASER AT 160 NM. Borgstrom, S. A. (Lund Inst. of Technology, Sweden). Opt. Commun.; 11: No. 2, 105-108(Jun 1974).

A simple low-divergence multi-electrode nanosecond-pulse gas laser suitable for short-lived self-terminating transitions is described. For H_2 a saturated peak power of about 3 kW and a halfwidth (fwhm) of 1 ns at 160 nm have been obtained. Simultaneous stimulated emission at 889.88 nm with 0.9 kW peak power has been observed. (Elect. Electron. Abstr.)

3328 COUPLED LASER MODE LOCKING BY TWO-QUANTUM INTERACTION. Neuhauser, W.; Toschek, P. E. (Univ., Heidelberg). Opt. Commun.; 11: No. 4, 331-334(Aug 1974).

In a double laser oscillator operating on the $3s_2$-$2p_4$ and $2s_2$-$2p_4$ transitions of neon, the red oscillation was mode-locked. The locking was transferred to the other oscillation via the common level. Two alternative round-trip phases of the circulating light pulses occurred. The in-phase state is ascribed to a Raman-like two-quantum interaction. (Elect. Electron. Abstr.)

3329 BROADBAND TUNABILITY OF DYE LASERS. Mau, A. W. H. (Australian National Univ., Canberra). Opt. Commun.; 11: No. 4, 356-359(Aug 1974).

A double compartment dye cell to hold two more dyes has been found to increase the frequency range of dye lasers. Results are compared with those obtained by mixing the same two dyes in a single cell. The dye cells are transversely pumped by a nitrogen laser. Broadband tunability results from dyes having similar absorption ranges but different Stokes shifts. (Elect. Electron. Abstr.)

3330 DIFFUSION PROBLEMS ARISING IN THE LINEAR THEORY OF GAS-DYNAMIC AND CHEMICAL LASERS. Preobrazhenskii, N. G. Zh. Prikl. Mekh. Tekh. Fiz.; No. 2, 32-37(1974). (In Russian).

A system of linear equations for multicomponent convective diffusion is successively reduced, taking account of the special conditions in a laser. A method is proposed for diagonalization of the matrix of diffusion coefficients by which the multicomponent problem is reduced to a series of single component problems. The superposition of relaxation modes is considered. Taking an HF diffusion-type amplifier as an example, the effect of particle angular asymmetry on power output is analyzed. (Elect. Electron. Abstr.)

3331 RECOMBINATION LASER WITH A SUPERCOOLED PLASMA GENERATED BY AN ELECTRON BEAM. Gudzenko, L. I.; Nezlin, M. V.; Yakovlenko, S. I. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 18: No. 9, 1218-1221(Mar 1974).

Translated from Zh. Tekh. Fiz.; 43: No. 9, 1931-1937(Sep 1973).

A theoretical feasibility study of a cw laser based on a recombining quasi-stationary plasma is presented. The plasma is produced by injecting a high current electron beam (100 keV, 10 to 100 A cm^{-2}) into a dense gas, $\sim 10^{19}$ cm^{-3}. The estimates suggest that such a laser is feasible. (Elect. Electron. Abstr.)

3332 DUAL-WAVELENGTH OPERATION OF TWO COUPLED DYE LASERS. Marowsky, G. (Max-Planck-Inst., Gottingen, Ger.); Zaraga, F. Opt. Commun.; 11: No. 4, 343-345(Aug 1974).

The analysis of the influence of an intracavity absorbing dye cell on the spectral characteristics of a free running dye laser leads to the operation of two coupled dye lasers. A powerful flashlamp-pumped dye ring laser pumps a secondary intracavity dye laser with a conversion efficiency of 30%. Both wavelengths are independently tunable and cover the spectral range from 580 nm to 652 nm in the case of the dye combination rhodamine 6G and cresyl violet. (Elect. Electron. Abstr.)

3333 LASER PERFORMANCE AND STABILITY OF FLUORINATED COUMARIN IN DYES. Schimitschek, E. J. (Naval Electronics Lab. Center, San Diego, CA); Trias, J. A.; Hammond, P. R.; Atkins, R. L. Opt. Commun.; 11: No. 4, 352-355(Aug 1974).

Several new coumarin derivatives are reported and their relative photochemical stability under flash and cw excitation is investigated. There seems to be no simple relation between the cw bleaching rate and the number of laser shots obtainable from any particular dye solution. (Elect. Electron. Abstr.)

3334 PROCESSES OF FORMATION OF ULTRASHORT LASER PULSES. Chekalin, S. V. (Inst. of Spectroscopy, Moscow). Opto-Electronics; 6: No. 4, 249-261(Jul 1974).

Experimental results on both the processes involved in the establishment of ultrashort light pulses during their build-up from noise and in their subsequent growth and narrowing are described and reviewed. Schemes for the improvement of the USP train are suggested. (Elect. Electron. Abstr.)

3335 PERFORMANCE CHARACTERISTICS OF A HIGH-PRESSURE CO_2-N_2 LASER PUMPED BY ELECTRON-BEAM-CONTROLLED DISCHARGE. Byszewski, W. W. (Inst. of Fundamental Technological Research, Warsaw). Acta Phys. Pol.; A47: No.2, 207-215(Feb 1975).

Some new experimental results of investigations of a CO_2-N_2 molecular laser working at a pressure from 1 to 8 atm are presented. Gas molecules were excited by a uniform electrical discharge controlled by a high energy electron beam. The variation of the following coefficients with changes of the initial parameters were measured: (1) the total efficiency of the energy conversion, and (2) small signal gain. The theoretical estimates agree qualitatively with the results obtained experimentally. (auth)

3336 TEMPERATURE DEPENDENCE OF SPECTRAL EMISSION FROM SEMICONDUCTOR LASERS SHOWING LONG TIME DELAYS. Thomas, B.; Mistry, D.; Davies, C. F. L. (Univ. of Wales, Cardiff). IEEE J. Quant. Electron.; QE-10: No. 4, 401-405 (Apr 1974).

From Institute of Physics, Quantum Electronics Conference; Manchester, England (10 Sep 1973).

Some semiconductor lasers show long time delays when operated at a temperature above a characteristic critical value. This long time delay can only be explained in terms of a saturable absorption mechanism, and a recent model attributing this mechanism to the

impurity band tails has successfully explained the kinetics and the current and temperature dependence of the delays. The model also predicts that the onset of long time delays is accompanied by a change in photon energy of the laser spectrum. Measurements of laser emission spectra over a range of temperatures have shown such changes in all our lasers with long time delays and this evidence validates the band tail saturable absorption model for long time delays. (auth)

3337 EXPERIMENTS ON TRANSVERSE MODE LOCKING OF CIRCULAR CYLINDRICAL OPTICAL BEAMS AND CERTAIN FLAT BEAMS. Haug, C.; Whinnery, J. R. (Univ. of California, Berkeley). IEEE J. Quant. Electron.; QE-10: No. 4, 406-408(Apr 1974).

Transverse mode locking of the Laguerre forms with proper magnitudes and phases in an optical beam with circular cylindrical symmetry can produce a beam with time-varying spot size and intensity. The effect is demonstrated by locking two modes of the cylindrically symmetric set, TEM/sub 00q/ and TEM/sub 10q/ of an He–Ne 6328-A laser with relative amplitudes 1 and 0.6, respectively. Verification of the time-varying spot was by sampling of the beam with an iris moved about the beam at constant radius. The shape and phase of the detected pulses agreed with predictions for the mode-locked beam. For a flat strip beam, the rectangular TEM/sub 00q/, TEM/sub 20q/, and TEM/sub 40q/ modes were locked with relative amplitudes 1, 0.5, and 0.3, respectively. A beam with time-varying width resulted and was sampled with a slit. (auth)

3338 PHOTON STATISTICS OF A CW DYE LASER WITH AND WITHOUT INTERNAL ETALONS. Davidson, F. (John Hopkins Univ., Baltimore); Chao, C. M.; Tittel, F. K.; Hohimer, J. P. IEEE J. Quant. Electron.; QE-10: No. 4, 409-412(Apr 1974).

Measurements were made to determine the photocount statistics and photocount correlations of a cw dye laser operated with and without internal etalons to achieve narrow linewidth. In addition, estimates of the mean laser light intensity as a function of time were made from photocount count records and the use of a newly developed stochastic estimation procedure. (auth)

3339 PRINCIPLES OF DISTRIBUTED FEEDBACK AND DISTRIBUTED BRAGG-REFLECTOR LASERS. Wang, S. (Univ. of California, Berkeley). IEEE J. Quant. Electron.; QE-10: No. 4, 413-427(Apr 1974).

Wave propagation in periodic waveguides is analyzed by decomposing the eigen Bloch waves into traveling-wave components. It is shown that the principal components consist of a primary forward wave, a primary backward wave, and their Bragg-scattered secondary waves. One important parameter is the coupling constant s due to Bragg scattering, which relates the secondary wave to the respective primary wave. Laser threshold condition is then obtained by applying the continuity of tangential E and H at the two boundaries. The results thus obtained are general and applicable to thin-film lasers with various waveguide structures. The laser threshold condition of thin-film Bragg lasers is expressed in terms of two effective reflection coefficients for easy comparison with conventional lasers. For appreciable reflection, a significant change either in the propagation constant or in the coupling constant is required. Two basic types of thin-film Bragg lasers are distributed-feedback (DFB) lasers in which Bragg scattering is confined to the active medium and distributed-Bragg-reflector (DBR) lasers in which Bragg scattering is limited to regions beyond the active medium. The threshold gain, frequency control, and mode selectivity for both types are analyzed and the analyses are applied to GaAs and Nd lasers. It is shown that DBR lasers should have a lower threshold gain and a better mode selectivity than DFB lasers. For distributed-feedback effect to play a significant role in thin-film Bragg lasers, the product kappaL/sub int/ must be greater than unity where kappa is the distributed-feedback coefficient and L/sub int/ is the interaction length. Advantages for having periodic structures outside the active medium so as to relax constraints on kappa and L/sub int/ are also discussed. (auth)

3340 TUNABLE MEDIUM INFRARED GENERATION IN SILVER THIOGALLATE ($AgGaS_2$) BY DOWN-CONVERSION OF FLASH-PUMPED DYE-LASER RADIATION. Hanna, D. C.; Rampal, V. V.; Smith, R. C. (Univ. of Southampton, Eng.). IEEE J. Quant. Electron.; QE-10: No. 4, 461-462(Apr 1974).

The outputs of flash-lamp pumped rhodamine 6G and rhodamine B lasers have been mixed in a $AgGaS_2$ crystal. The generated difference frequency radiation has been tuned from 8.7 to 11.6 mu m. Measurements of laser-induced damage of $AgGaS_2$ have been made in the region of 600 nm which show a rapid fall in threshold with decreasing wavelength. (auth)

3341 PHOTOINITIATED TEA CO LASER AT LOW TEMPERATURES. Cohn, D. B. (Northrop Corp., Hawthorne, CA). IEEE J. Quant. Electron.; QE-10: No. 4, 459-461(Apr 1974).

Photoinitiated discharges between continuous electrodes have been stabilized in high-pressure (CO, He, N_2) laser mixtures at 100°K. A ½-l device, with restricted output aperture, has yielded 1.9-J/l atm (160 torr, 100°K) in smooth 240-mu s-long pulses with an efficiency of 2 percent, representing a sevenfold improvement over previous results. The unrestricted output is estimated at 5.7-J/l atm with 6 percent efficiency. (auth)

3342 DESIGN OF A BIREFRINGENT FILTER FOR HIGH-POWER DYE LASERS. Holtom, G. (Wayne State Univ., Detroit); Teschke, O. IEEE J. Quant. Electron.; QE-10: No. 8, 577-579 (Aug 1974).

A birefringent filter which is suitable for tuning dye lasers having high gain is described. Transmission and tuning characteristics for the filter are calculated. Several appropriate designs having small sidebands, a minimum number of elements, and narrow passbands are discussed. (auth)

3343 KINEMATIC MODELING OF cw CO ELECTRIC-DISCHARGE LASERS. Hall, R. J.; Eckbreth, A. C. (United Aircraft Research Labs., East Hartford, CT). IEEE J. Quant. Electron.; QE-10: No. 8, 580-590(Aug 1974).

A rate equation analysis of convective CO electric-discharge lasers (EDL's) is presented. The spatial distribution of CO vibrational levels is governed by a kinetic master equation wihch contains terms representing electron impact pumping, vibration-vibration (VV) and vibration-translation (VT) energy transfer, and spontaneous and stimulated emission. Electronic pumping rates are derived from the solution to the electron Boltzmann equation. Spectral distributions of small-signal gain and optical flux are calculated in terms of the cross sections for these processes. Good agreement is obtained between predicted and experimentally reported gain and power spectra. For coincident discharge/cavity configurations, the quasi-steady small-signal gain is predicted to have a strong dependence on translational temperature for representative operating conditions. The predicted power output for a wide variety of bulk gas and plasma properties is found to be correlated by a simple energy-time parameter. The performance of other devices which involve separate discharge and cavity regions is also examined. The importance of the threshold excitation energy in understanding a variety of configurations is discussed. (auth)

3344 STABILITY OF AN INTRACAVITY FREQUENCY-DOUBLED Nd:YAG LASER. Kennedy, C. J.; Barry, J. D. (Wright-Patterson Air Force Base, OH). IEEE J. Quant. Electron.; QE-10: No. 8, 596-599(Aug 1974).

Single-mode rate equations are solved in the small-signal limit to determine the oscillation frequency and decay constant for relaxation oscillations in an intracavity frequency-doubled Nd:YAG laser. It is found that improved stability is noted for nonlinear coupling constants greater than 10^{-5}. Eventually, cavity perturbations become critically damped with increased coupling, and oscillatory behavior disappears. (auth)

3345 CHARACTERISTICS OF TUNGSTEN–NICKEL POINT CONTACT DIODES USED AS LASER HARMONIC-GENERATOR MIXERS. Sakumu, E.; Evenson, K. M. (National Bureau of Standards, Boulder, CO). IEEE J. Quant. Electron.; QE-10: No. 8, 599-603(Aug 1974).

Properties of tungsten–nickel point contact diodes, when used as harmonic-generator mixers, were measured. The measured properties are those which will be useful to workers wishing to use these high-speed devices (faster than 10^{-14} s). Some of the properties measured were: the decrease in signal with mixing order; the detected signal as a function of laser frequency; and the power required to optimize the harmonic beat notes. (auth)

3346 DIFFRACTION BY APODIZED APERTURES. Hadley, G. R. (Sandia Labs., Albuquerque, NM). IEEE J. Quant. Electron.; QE-10: No. 8, 603-608(Aug 1974).

This paper investigates the diffraction of light by apodized apertures. The diffraction equation is solved numerically starting with an apertured plane wave or Gaussian beam. A function chosen to characterize spatial intensity modulation is then plotted versus Fresnel number for differing amounts of apodization so that the benefit gained thereby may be quantitatively assessed. In addition, the energy loss incurred due to insertion of an apodized aperture in front of an existing hard aperture is determined. (auth)

3347 GAIN VERSUS TIME IN THE CF_3I IODINE PHOTODISSOCIATION. Palmer, R. E.; Gusinow, M. A. (Sandia Labs., Albuquerque, NM). IEEE J. Quant. Electron.; QE-10: No. 8, 615-616(Aug 1974).

A late-time rise in gain for the CF_3I iodine photodissociation laser has been reported by other investigators. Within experimental error no rise in gain after the initial photolytic flash was observed in the present experiment. (auth)

3348 SECOND-HARMONIC GENERATION IN CDA AND CD*A. Kato, K. (Japan Defence Agency, Tokyo). IEEE J. Quant. Electron.; QE-10: No. 8, 616-618(Aug 1974).

Efficient second-harmonic generation at 5321 A has been achieved in CDA and CD*A. At 50-MW pump power, loss-free peak power-conversion efficiency of 57 percent and 45 percent were obtained in CDA and CD*A, respectively. The nonlinear optical constant, corrected for multimode fluctuations, was found to be d_{36}(CDA) equals d_{36}(CD*A) equals $(0.96 \pm 0.11) \times 10^{-9}$ ESU, which corresponds to d_{36}(CDA) equals d_{36}(CD*A) equals 0.92 x d_{36}(KDP). In addition, the temperature variation of the birefringence $d(n_2^2 - n_1^2)/dT$ has been measured to be $(8.0 \pm 0.2) \times 10^{-6}\ ^0C^{-1}$ for CDA and $(7.8 \pm 0.2) \times 10^{-6}\ ^0C^{-1}$ for CD*A. (auth)

3349 FLASHLAMP-PUMPED YAG:Nd^{3+} LASER ACTION AT KILOHERTZ RATES. Corcoran, V. J.; McMillan, R. W.; Barnoske, S. K. (Martin Marietta, Aerospace, Orlando, FL). IEEE J. Quant. Electron.; QE-10: No. 8, 618-620(Aug 1974).

Laser action at high repetition rates with flashlamp pumping has been achieved in a YAG:Nd^{3+} laser rod. With the resonant charging techniques used in the experiments, the repetition rate is limited by the heating of the laser rod. (auth)

3350 CHARACTERISTICS OF AN Nd:CaLaSOAP MODE-LOCKED OSCILLATOR. Eckardt, R. C.; DeRosa, J. L.; Letellier, J. P. (Naval Research Lab., Washington, DC). IEEE J. Quant. Electron.; QE-10: No. 8, 620-622(Aug 1974).

Neodymium doped calcium lanthanum silicate oxyapatite (Nd:(Nd:CaLaSOAP) has properties intermediate between Nd:YAG and Nd:glass that make it desirable for use as a pulsed-mode-locked oscillator at 1.06 mu. Time resolve spectroscopy, high speed image converter streak recordings, and two-photon fluorescence pulse duration measurements were used to investigate the output of such a laser. Pulse durations from 5 to 15 ps were observed under different operating conditions. (auth)

3351 HIGH EFFICIENT UV GENERATION AT 3472 A IN RDA. Kato, K. (Japan Defence Agency, Tokyo). IEEE J. Quant. Electron.; QE-10: No. 8, 622-624(Aug 1974).

The high efficient generation of the second harmonic of ruby laser in rubidium dihydrogen arsenate (RDA) is reported. A peak harmonic power of 62 MW was obtained with a fundamental power of 110 MW. In addition, the temperature variation of the birefringence has been measured to be $d(n_2^2 - n_1^2)/dT$ equals $(9.3 \pm 0.4) \times 10^{-6}\ ^0C^{-1}$. (auth)

3352 HIGH-POWER Ar–N_2 TRANSFER LASER AT 3577 A. Ault, E. R.; Bhaumik, M. L.; Olson, N. T. (Northrop Research and Tech. Center, Hawthorne, CA). IEEE J. Quant. Electron.; QE-10: No. 8, 624-626(Aug 1974).

A peak laser power of 0.5 MW with an estimated efficiency of 0.2 percent has been obtained at 3577 A from a mixture of 92 psia Ar and 8 psia N_2 which was excited by an E-beam of 400 A/cm^2 at 1.3 MeV in a 20-ns pulse. A saturation intensity of approximately 100 kW/cm^2 was deduced and a beam divergence of 10 mrad was measured from the laser having a 10-cm gain length. (auth)

3353 NONLINEAR INTERACTION BETWEEN OPPOSITE WAVES WITH VARIOUS POLARIZATION IN A RING LASER. Zborovskii, V. A.; Fradkin, E. E. Zh. Eksp. Teor. Fiz.; 66: No. 4, 1219-1228(Apr 1974). (In Russian).

Nonlinear polarization effects in a gas laser with a ring cavity possessing polarization anisotropy and in a zero magnetic field were investigated on basis of the semiclassical vector theory. It is shown that the frequencies and intensities of opposite wave generation are different due to differences of their polarization vectors and non-linear anisotropy of the active medium. The frequency difference of the opposite waves increases from zero proportionally to the generation intensity. Expressions for the frequencies and intensities of wave generation were obtained as functions of the cavity and active medium parameters. (Elect. Electron. Abstr.)

3354 EXPERIMENTAL INVESTIGATION OF EMISSION PROPERTIES OF A COAXIAL NITROGEN LASER. Bergstedt, K.; Hulsmann, H. G. (Ruhr Univ., Bochum, Ger.). Z. Phys.; 269: No. 3, 195-203(1974). (In German).

Inspection of the emission properties of a coaxial nitrogen laser with pulses of about 2 ns half-width and peak powers exceeding 20 kW leads to the following results: (a) For the first time not only the $0 \rightarrow 0$ vibrational band but also the $0 \rightarrow 1$ and $1 \rightarrow 0$ bands in the second positive system of molecular nitrogen are observed in superradiant emission at gas temperatures of 300 and 400°K. Increasing the temperature in the laser has no considerable effect on the spectral intensity distribution. The theoretical results of Kaslin and Petrash (1966) for the dependence of the gain on the rotational quantum numbers of the upper laser level are verified qualitatively. (b) The main reason for the decrease in power with increasing time of laser operation is found to be a growing rise time of the discharge current caused by the temperature dependence of the laser material dielectric loss factor. (c) At certain working conditions laser pulses with two time separated power peaks are observed; no definitive explanation of this effect can be offered. (Elect. Electron. Abstr.)

3355 THEORY OF TWO-CHANNEL LASER GENERATION IN SPECTRALLY HETEROGENEOUS MEDIA. III. Width of Generation Line. Efimenko, L. V.; Mashkevich, V. S. Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 7, 1193-1202(Jul 1974). (In Russian).

A kinetic theory was constructed for the width of two-channel laser generation line in the medium with heterogeneously broadened luminescence lines. A narrow-line generation spectrum was considered for two opposite cases: presence and absence of correlation between different frequencies of a separate active center. A dependence was found of the line width on the intensity. It is shown that the presence of the second generating channel must result in the narrowing of the generation line. (Elec. Electron. Abstr.)

3356 Nd:GLASS LASER AMPLIFIER. Isbasescu, M.; Stratan, A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 10, 1107-1109(1974).

A single stage laser amplifier of maximum 3 energy gain is described. It does not saturate for small input signals but high energy pumping. (auth)

3357 THEORY OF TWO-CHANNEL LASER GENERATION IN SPECTRALLY HETEROGENEOUS MEDIA. II. Correlated Frequencies. Efimenko, L. V.; Mashkevich, V. S. Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 7, 1185-1192(Jul 1974). (In Russian).

The theory of two-channel laser generation in a spectrally heterogeneous medium was constructed for the case of correlated frequencies of a separate active center. The generation spectrum was obtained. Its picture was determined by the parameter which is equal to the ratio of the effective half-widths of the luminescence lines of a separate active center on different transitions. Dependence of the radiation intensity on pumping was obtained for each generating channel. (Elec. Electron. Abstr.)

3358 CHEMILUMINESCENT REACTIONS IN GASES AND THEIR POSSIBLE USE IN CHEMICAL LASERS BASED ON ELECTRON PHOTOTRANSITIONS. Kochelap, V. A.; Kukibnyi, Yu. A.; Pekar, S. I. Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 5, 848-450(May 1974). (In Russian).

Criteria for population inversion and amplification coefficients of gases in which chemiluminescent reactions take place are examined. The methods of evaluation involve either the absorption coefficients of the reaction products together with Einstein's thermodynamic equations or the various parameters of the chemiluminescent reactions, i.e., spectral distribution of emission and recombination velocities. For the reaction $SO + O \rightarrow SO_2 + \omega_1$ the amplification factor was found to be 0.14 $cm^{-1}P_O P_{SO}$ at 4500 Å where P_O and P_{SO} are the partial pressures of the interacting gases. (Elect. Electron. Abstr.)

3359 SPATIALLY COHERENT RADIATION FROM AN ARRAY OF GaAs LASERS. Philipp-Rutz, E. M. (IBM Federal Systems Division, Gaithersburg, MD). Appl. Phys. Lett.; 26: No. 8, 475-477(15 Apr 1975).

Spatially coherent radiation from a monolithic array of three homostructure GaAs lasers is reported. The three lasers, with their mirror faces antireflection coated, are operated in an external optical cavity built of spherical lenses and plane mirrors. The spatially coherent beam formation makes use of the Fourier transformation property of the internal lenses. The transverse mode control is performed by a spatial filter. The optical peak power at room temperature of the device was measured to be 5 W, three times the power of a single laser in the array. From the synthesized far-field distribution which was evaluated, it is concluded that the laser radiation is of spatial coherence. (auth)

3360 SELECTION AND STABILIZATION OF LONGITUDINAL MODES BY SPACING OF LASER CAVITY COMPONENTS. Draegert, D. A. (Bell Labs., Murray Hill, NJ). IEEE J. Quant. Electron.; QE-10: No. 5, 476-479(May 1974).

The longitudinal mode spectrum of a solid-state ion laser can be greatly simplified and stabilized by spacing the rod and the mirrors according to a simple rule: the optical path between each end mirror and the nearest end of the rod should be an integral multiple of the optical length of the rod. Application of this rule can reduce the number, increase and regularize the frequency spacing, symmetrically distribute the intensities, and increase the temporal stabilization of the oscillating longitudinal modes. These remarkable effects were demonstrated with a continuous Nd:YAG laser that was constructed with sev-

eral different spacings of cavity elements. The rule is probably the result of absorption loss that is localized at the surfaces of the rod. Other models, limitations, and generalizations of the rule are also discussed. (auth)

3361 J-DEPENDENCE OF ROTATIONAL RELAXATION IN THE CO_2 00^01 VIBRATIONAL LEVEL. Jacobs, R. R.; Thomas, S. J.; Pettipiece, K. J. (Lawrence Livermore Lab., CA). IEEE J. Quant. Electron.; QE-10: No. 5, 480-486(May 1974).

Observations are presented on the J-dependence of rotational relaxation in the CO_2 00^01 vibrational level for mixtures of CO_2, He, and N_2. The experiment consists of injecting a saturating approximately 2-ns pulse at the P(20) line in the 10.4-mu CO_2 band into a low-pressure CO_2-laser amplifier while simultaneously monitoring the transient gain response of an overlapping weak probe beam in the 9.4-mu band restricted to operate on any of the transitions P(10)-P(34). The data show that the decay times of the various J states in the CO_2 00^01 level get progressively longer for increasing or decreasing J value centered about the perturbed J equals 19 state. Such behavior may be expected to have a significant effect on the efficiency of energy extraction and pulse shapes in CO_2 amplifiers for nanosecond and, especially, subnanosecond laser pulses. An analysis using a coupled set of rate equations to describe the rotational level populations is presented in which consideration is given only to DELTA J equals 2 changes in collision. The analysis, when compared with the data, indicates that collisions in which DELTA J changes by more than two units must also be considered. (auth)

3362 EFFECT OF CENTRIFUGAL DISTORTION ON CO_2-LASER FREQUENCIES. Menzies, R. T. (California Inst. of Tech., Pasadena). IEEE J. Quant. Electron.; QE-10: No. 5, 486-489(May 1974).

An analysis of the effects of higher order centrifugal distortion terms on $^{12}C^{16}O_2$-laser frequencies is presented. This analysis, coupled with recent high-accuracy measurements of $^{12}C^{16}O_2$-laser beat frequencies by Petersen et al. at the National Bureau of Standards, points out the weakness of existing frequency tables for high J lines. Expected values for both H and L centrifugal distortion coefficients are calculated, and J values for which these terms become important are discussed. (auth)

3363 LASER ACTINOMETRY OF FLASH-PHOTOLYZED H_2/F_2/He MIXTURES. Suchard, S. N.; Sutton, D. G. (Aerospace Corp., El Segundo, CA). IEEE J. Quant. Electron.; QE-10: No. 5, 490-493(May 1974).

Actinometric and time-to-threshold experiments with flash-initiated H_2/F_2/He mixtures have been modeled with the RESALE chemical laser code. Comparison of the salient features of both experiments with those predicted by the code determines the efficiency of a xenon flashlamp in dissociating F_2. The results indicate that a 1000-J 20-mu s full width at half maximum (FWHM) lamp is capable of dissociating 1.2 percent of the F_2 initially present in dilute F_2/He mixtures. (auth)

3364 HYSTERESIS EFFECTS IN THE MODE LOCKING OF A He–Ne LASER BY A Ne DISCHARGE CELL. Teng, T. C.; Pao, Y. H. (Case Western Reserve Univ., Cleveland). IEEE J. Quant. Electron.; QE-10: No. 5, 494-496(May 1974).

The existence of hysteresis effects associated with the mode locking of a He–Ne laser operating at 6328 A by a Ne cell when appropriate excitations, losses, lengths, and positions of both laser tube and Ne cell are chosen have been observed. The hysteresis effects manifest themselves in the pulsing rate, the pulsewidth, and the power output. (auth)

3365 PULSED-WAVEGUIDE LASER. Rudko, R. I. (Raytheon Research Div., Waltham, MA). IEEE J. Quant. Electron.; QE-10: No. 5, 497-498(May 1974).

A pulsed-waveguide CO_2 laser is described for which no electronic pulser is required because the discharge properties of the waveguide laser and the external resistance and capacitance form a relaxation oscillator. Peak powers of 15 W were obtained at repetition rates up to 20 kHz for the 10-cm discharge. (auth)

3366 PHYSICAL CONSTRAINTS ASSOCIATED WITH THE DEVELOPMENT OF A LASER BASED ON ELECTROCHEMILUMINESCENCE. Measures, R.M. (Institute for Aerospace Studies, University of Toronto, Downsview, Ontario). Appl. Opt. 14: No. 4, 909-916 (Apr 1975).

A theoretical study of the possibility of attaining laser action from an electrochemiluminescence system has been undertaken. A simple model has been found that is capable of predicting the width of the excited state creation zone in terms of the peak excited state concentration. This relation reveals that diffraction losses are likely to be catastrophic if the concentration of the excited molecules is made sufficient to ensure that the optical gain of the medium exceeds the losses due to the laser cavity. This imposes an extremely severe physical constraint on the development of a laser based on radical-ion annihilation. (auth)

3367 TUNING OF A DYE LASER BY A BIREFRINGENT FABRY-PEROT ETALON. Okada, M.; Shimizu, S.; Ieiri, S. (Broadcasting Science Research Laboratory, NHK Japan Broadcasting Corporation, 1–10–11 Kinuta, Setagaya, Tokyo, 157 Japan). Appl. Opt. 14: No. 4, 917-922 (Apr 1975).

It is shown that a birefringent Fabry-Perot etalon, which has a simple configuration similar to Lyot's filter except for mirror coatings on the end-faces of birefringent crystal, is useful for tuning of dye lasers because of the high finesse realized by two stages of commonly used Fabry-Perot etalons. Experimental tuning characteristics of $PbMoO_4$ and $LiNbO_3$ birefringent Fabry-Perot etalons in a pulsed dye laser, pumped by the second harmonic of a repetitively Q-switched Nd:YAG laser, are in agreement with the theory. (auth)

3368 ENVELOPE GAIN SATURATION IN DISTRIBUTED-FEEDBACK LASERS. Hill, K.O.; Watanabe, A. (Communications Research Centre, Department of Communications, Ottawa, Canada KIN 8T5). Appl. Opt. 14: No. 4, 950-961 (Apr 1975).

Gain saturation is treated by formulating a model that accounts for the dependence of gain on irradiance level in distributed-feedback lasers. Solutions of the coupled-mode equations of the model are obtained numerically and are presented for both overcoupled and undercoupled laser structures (KL in the 10^{13}–10 range). Parasitic losses that are distributed uniformly within the structure are found to influence the output power characteristics of distributed-feedback lasers. Also the optimum coupling strength that results in the most efficient conversion of pump power to useful laser output is determined. The optimum coupling strength for any distributed-feedback laser is dependent on the magnitude of the parasitic losses and on the required output-power level. (auth)

3369 INFLUENCE OF FLUID-DYNAMIC PHENOMENA ON THE OCCURRENCE OF CONSTRICTION IN cw CONVECTION LASER DISCHARGES. Wiegand, W.J.; Nighan, W.L. (United Aircraft Research Laboratories, East Hartford, Connecticut 06108). Appl. Phys. Lett. 26: No. 10, 554-557 (15 May 1975).

The influence of gas residence time, turbulence, and discharge uniformity on the electrical power density threshold for glow constriction has been investigated for conditions typical of high-power cw convection-cooled molecular lasers. Relatively independent evaluation of the effect of these properties indicated that each has an important bearing on plasma stability. Reduction of fluid residence time in the discharge region was found to result in an approximately proportionate increase in the electrical power density at which constriction occurred in CO_2 laser mixtures for pressures in the 20–200-Torr range. (auth)

3370 HIGH-PRESSURE CHEMICAL WAVEGUIDE LASER. Poehler, T.O.; Walker, R.E.; Leight, J.W. (Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland 20910). Appl. Phys. Lett. 26: No. 10, 560-561 (15 May 1975).

The exothermic chain reactions between deuterium and fluorine have been used to produce laser emission from carbon dioxide in a high-pressure chemical waveguide laser. Chemical chain reactions initiated by flash photolysis of this system produced 10.6-μm radiation from a 3-mm-diam laser tube having an effective length of 50 cm. Lasing occurs in stable D_2-F_2-CO_2-He mixtures at pressures as high as 1 atm with peak power of 2.5 kW for pulses of 20-μsec duration. (auth)

3371 COMMENT ON "DYNAMIC MODEL OF HIGH-PRESSURE RARE-GAS EXCIMER LASERS". Gerardo, J.B.; Johnson, A.W. (Sandia Laboratories, Albuquerque, New Mexico 87115). Appl. Phys. Lett. 26: No. 10, 582-584 (15 May 1975).

The model of the rare-gas excimer lasers that was recently proposed by Werner *et al.* is shown to be inconsistent with some experimental measurements of xenon dimer laser gain and laser intensity. Measurements of the laser intensity and laser-medium gain of a xenon dimer laser show that the laser pulse terminates well before the laser-medium gain falls below the prelasing losses of the optical resonator. The measured value of the stimulated-emission cross section for the xenon dimer laser is $(1.05\pm0.2)\times10^{-25}$ A cm^2 at 1720 Å, where A is the transition probability of the upper energy level of the laser. (auth)

3372 AN ELECTRON SYNCHROTRON MASER BASED ON AN INTENSE RELATIVISTIC ELECTRON BEAM. Granatstein, V.L.; Sprangle, P.; Parker, R.K.; Herndon, M. (Naval Research Laboratory, Washington, D. C. 20375). J. Appl. Phys. 46: No. 5, 2021-2028 (May 1975).

An electron cyclotron maser has been operated with an output of ≈50 MW of coherent radiation at a frequency ≈8 GHz. A magnetic field configuration is described which effectively converts streaming electron energy into energy transverse to the streaming direction. The redistribution of beam energy makes available a source of free energy to be converted, via an instability, into radiation at the Doppler-shifted relativistic electron cyclotron frequency. A nonlinear theoretical analysis shows that the coherent synchrotron radiation is a relativistic negative mass type instability reflecting the fact that the cyclotron frequency is a

function of the electron energy. The emission was narrow band with a coherence time > 50 nsec, and was also spatially coherent being primarily radiated into the TE_{01} circular waveguide mode. The potential for making a frequency tunable maser by employing a tapered drift tube has also been demonstrated. (auth)

3373 PARAMETRIC PERFORMANCE PREDICTIONS FOR HIGH-POWER PULSED ELECTRIC CO LASERS. Center, R.E.; Caledonia, G.E. (Avco Everett Research Laboratory, Everett, Massachusetts 02149). J. Appl. Phys. 46: No. 5, 2215-2222 (May 1975).

A kinetic model of the pulsed electrical CO laser is used to survey the time-dependent laser performance on parameters such as gas mixture, initial translational temperature, and discharge pulse length for both multiline and selected-line operation. Predictions are presented for the total output efficiency, spectral distributions of the stimulated transitions, energy partitioning in the vibrational and translational modes, and the translational temperature history in CO-N_2 mixtures. A brief description of the kinetic model is included. Simple scaling relationships are presented which can be used to scale the results to other densities in the pressure-broadened regime. (auth)

3374 THEORETICAL STUDIES OF THE KINETICS OF CHEMICAL LASERS. Igoshin, V. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 76: 117-145(1974). (In Russian).

This study deals with the circle of problems associated with the theory of chemical lasers. Mathematical models are developed for the processes occurring in mixtures of $H_2 + F_2$, and $D_2 + F_2 + CO_2$. Detailed consideration is given to the effect of various factors on the inversion population. (tr-SJR)

3375 MEASUREMENT OF LENGTH SHIFTS DOWN TO 10^{-5} A WITH A THREE-MODE LASER. Boersch, H.; Eichler, H. J.; Pfundstein, M.; Wiesemann, W. (Technical Univ., Berlin). IEEE J. Quant. Electron.; QE-10: No. 6, 501-504(Jun 1974).

The frequency of one axial mode of a three-mode He/Ne laser can be tuned independently from the other modes if a third mirror is added to the usual two laser mirrors. Provided the adjustment is correct, the frequency shift is proportional to a change of the optical path length between the third mirror and the neighboring laser mirror. By observing the beat frequency of the laser, measurements of optical path variations down to 10^{-5} A are possible. (auth)

3376 OPTICAL DISTORTION OF HEATED MIRRORS IN CO_2-LASER SYSTEMS. Apollonov, V. V.; Barchukov, A. I.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). IEEE J. Quant. Electron.; QE-10: No. 6, 505-508(Jun 1974).

Using the model of an elastic half-space, the behavior of the reflecting mirror surface under the action of cw high-power CO_2-laser beams is considered. The temperature and the stress fields on the mirror surface are calculated. The three critical intensity values corresponding to the three regions of the mirror optical distortion are determined. It is shown that, when optical distortion is to be minimized, the elastic deformation is of great importance at laser flux densities two or three orders of magnitude smaller than those necessary to melt the material of the mirror. The magnitude of the mirror surface normal displacement is experimentally determined. The calculations are found to agree with the experimental data. (auth)

3377 FREQUENCY, INTENSITY, AND FIELD FLUCTUATIONS IN LASER OSCILLATORS. Yariv, A. (California Inst. of Tech., Pasadena); Caton, W. M. IEEE J. Quant. Electron.; QE-10: No. 6, 509-515(Jun 1974).

The basic differential equation governing laser noise is derived from classical and quantum mechanical considerations. Its linearized Van Der Pol form is used to derive the frequency, field, and intensity fluctuation spectra. (auth)

3378 PHOTOEXCITATION AND PHOTODISSOCIATION LASERS. Part I. Nitric Oxide Laser Emissions Resulting From $C(^2pi)$ Yields $A(^2SIGMA^+)$ and $D(^2SIGMA^+)$ Yields $A(^2SIGMA^+)$ Transitions. Lin, M. C. (Naval Research Lab., Washington, DC). IEEE J. Quant. Electron.; QE-10: No. 6, 516-521(Jun 1974).

1-mu m laser emission was detected when NO or NO_2 was flash-photolyzed, with or without dilution, in the vacuum UV above 165 nm. The emission was identified as the $C(^2pi)$ yields $A(^2SIGMA^+)$ (0,0) and the $D(^2SIGMA^+)$ yields $A(^2SIGMA^+)$ (1,1) band transitions at 1.2237 and 1.1069 mu m, respectively. The C yields A(1,1) and D yields A(0,0) bands also lased weakly under better cavity conditions. The total intensity of the 1-mu m emissions was found to vary linearly with flash energy, indicating that the pumping mechanism involves a one-photon excitation process. The effects of various additives (He, Ar, H_2, CO, N_2, O_2, N_2O, CO_2, CF_4, and SF_6) have been studied. When both CO_2 and an excess amount of He or Ar were added to NO, 10.6-mu m CO_2-laser emission was observed concurrently with the 1-mu m emission. The 10.6-mu m emission is attributed to the near-resonant energy transfer process NO* (nu) + CO_2 (000) yields NO* (nu - 1) + CO_2 (001) where NO* (nu) represents the NO molecule in the nuth vibrational level of the A, C, or D state. Additional emissions at 2.6072 and 2.6380 mu m were also detected; however, their exact origins are not certain. (auth)

3379 TEA CO_2 LASER WITH OUTPUT PULSE LENGTH ADJUSTABLE FROM 50 NS TO OVER 50 MU S. Girard, A.; Beaulieu, A. J. (Gen-Tec Inc., Quebec). IEEE J. Quant. Electron.; QE-10: No. 6, 521-524(Jun 1974).

By adjusting the proportions of CO_2 and N_2 in a TEA laser gas mixture and by also adjusting the coupling losses of the optical resonator, it is shown that the same laser system can produce laser outputs of relatively uniform energy but with pulse lengths adjustable from 0.05 to 50 mu s. (auth)

3380 INVERSION MECHANISM OF THE MOLECULAR HYDROGEN VACUUM ULTRAVIOLET LASER. Gallardo, M.; Massone, C. A.; Garavaglia, M. (National Univ. of La Plata). IEEE J. Quant. Electron.; QE-10: No. 6, 525-526(Jun 1974).

The resonances in the 11 to 14-eV region produced in the e-H_2 interaction are suggested as mechanisms to invert the population between the upper laser states $C^1pi/sub\ u/$ and $B^1SIGMA/sub\ u/^+$ and the ground state $X^1SIGMA/sub\ g/^+$ of the hydrogen molecule. (auth)

3381 FREQUENCY STABILIZATION OF He-Ne LASERS BY SATURATED ABSORPTION. Brillet, A. (Laboratoire de l'Horloge Atomique, Orsay, France); Cerez, P.; Clergeot, H. IEEE J. Quant. Electron.; QE-10: No. 6, 526-528(Jun 1974).

The performances of He-Ne lasers stabilized by saturated absorption in methane at 3.39 mum and iodine at 633 nm have been compared from the point of view of their use as optical frequency standards. Both lasers have shown a frequency stability comparable with the cesium-beam frequency standard and a reproducibility much better than the krypton-lamp length standard. (auth)

3382 PULSE CHIRPING IN A Nd:YAG LASER. Kennedy, C. J. (Wright-Patterson Air Force Base, OH). IEEE J. Quant. Electron.; QE-10: No. 6, 528-530(Jun 1974).

The 1.06-mum output of a loss-modulation mode-locked and frequency-doubled Nd:YAG laser was examined using a microwave avalanche photodiode with a rise time of approximately 40 ps, and a scanning Fabry-Perot. The pulses were found to be transform limited only in the case where the 0.53-mum output of the laser was suppressed. When conversion efficiency was restored, the spectrum exhibited narrowing, but the pulses were much wider than the transform limit, indicating the presence of chirping. (auth)

3383 CW IODINE-ION LASER IN A POSITIVE-COLUMN DISCHARGE. Hattori, S. (Nagoya Univ., Japan); Kano, H.; Tokutome, K.; Collins, G. J.; Goto, T. IEEE J. Quant. Electron.; QE-10: No. 6, 530-531(Jun 1974).

In a positive-column He-I_2 discharge of a cataphoresis-type, cw laser oscillation of an output power around 10 mW for five visible lines has been first observed and output characteristics of three lines have been studied. (auth)

3384 CO_2-LASER PUMPING VIA TRANSFER FROM N_2 SPECIES PRODUCED FROM THE REACTION OF NO WITH DISCHARGED NITROGEN. McGee, T. J.; Powell, F. X. (Catholic Univ. of America, Washington, DC). IEEE J. Quant. Electron.; QE-10: No. 12, 853-860(Dec 1974).

The reaction of NO with active nitrogen produces, either directly or indirectly, vibrationally excited N_2, which species can transfer energy to CO_2 yielding laser lines at 10.6 u. Further, that the reaction of N atoms with NO yields N_2 in a vibrationally excited state has been verified. In this class of transfer laser, the discharge parameters are critical; different discharges produce species which can energize the transfer laser via different pumping mechanisms. (auth)

3385 EXPERIMENTAL STUDIES OF THF $O/O_2/CS_2$ CW CO CHEMICAL LASER. Jeffers, W. Q.; Wiswall, C. E. (McDonnell Douglas Corp., St. Louis). IEEE J. Quant. Electron.; QE-10: No. 12, 860-869(Dec 1974).

Experimental studies of cw transverse-flow chemical laser are reported. These studies include investigation of gas flow and mixing lengths, densities of chemical species in the reacting flow stream, and gas-additive effects on laser emission. This device has yielded the highest performance yet observed for CO chemical lasers with a specific output power of 65.5 J/g (29.7 kJ/lb) and a minimum chemical efficiency of 21 percent. It was found that additional chemical species are present in the flow stream beyond those predicted by a simple three-reaction model of the chemical kinetics. Gas additives have been found to give increases in total output power, and can also be used to enhance either high or low bands in the output spectrum. (auth)

3386 STIMULATED MAGNETO-COMPTON SCATTERING: A POSSIBLE TUNABLE FAR INFRARED AND MILLIMETER WAVE SOURCE. Sukhatme, V. P.; Wolff, P. A. (Massachusetts Inst. of Tech., Cambridge). IEEE J. Quant. Electron.; QE-10: No. 12, 870-873(Dec 1974).

Several authors have considered the possibility of using stimulated Compton scattering as a source of tunable coherent far infrared radiation. For a finite photon-electron interaction region, it is known that the gain is small. It is shown that there is a significant increase in the photon-electron scattering cross section and hence in the gain when the scattering is performed resonantly in a longitudinal dc magnetic field. It is found that under these conditions appreciable gain is available for pulsed operation. (auth)

3387 MECHANISMS OF HF LASER EMISSIONS FROM FLASH-INITIATED $CHFCl_1$ AND CH_2FCl–NO MIXTURES. Shortridge, R. G.; Lin, M. C. (Naval Research Lab., Washington, DC). IEEE J. Quant. Electron.; QE-10: No. 12, 873-879(Dec 1974).

HF infrared stimulated emission was observed from flash-initiated $CHFCl_2$–NO and CH_2FCl–NO mixtures above 165 nm. Several P(J) lines were detected between DELTAnu (2 yields 1) and (1 yields 0) in the $CHFCl_1$ system, while only (1 yields 0) lines were observed in the CH_2FCl system. Addition of D_2 generated DF emission in the former system, whereas it was absent in the latter. Detailed parametric study, including the mass spectrometric analysis of flashed products, showed that the principal laser-pumping reaction is CHF + NO yields $CHFNO^*$ yields $HF^* + CNO$. Other possible side reactions in these systems are discussed. No laser emission was detected from flashed CHF_2Cl–NO mixtures under the same experimental conditions. (auth)

3388 USE OF I_2 FILTERS FOR STABILIZING Ar^+ LASER FREQUENCY AND FOR ATTENUATING PARASITIC SCATTERING AT THE UNSHIFTED FREQUENCY IN A MOLECULAR SCATTERING SPECTRUM. Chisty, I. L.; Kitaeva, V. F.; Sobolev, N. N. (Lebedev Inst. of Physics, Moscow). IEEE J. Quant. Electron.; QE-10: No. 12, 888-892(Dec 1974).

The two-iodine-cell technique for obtaining spectra of molecular light scattering with strongly attenuated parasitic scattering is described. One cell is used to attenuate parasitic scattering light, the other to stabilize the laser frequency on the iodine absorption line. (auth)

3389 SOME OBSERVATIONS ON MULTIPLY IONIZED XENON LASER LINES. Pappalado, R. (GTE Labs., Inc., Waltham, MA). IEEE J. Quant. Electron.; QE-10: No. 12, 897-898(Dec 1974).

The intensity profile of the laser lines in pulsed xenon discharges is related to the Xe(IV) emission from the plasma "pinch." The period of the observed intensity modulation of the xenon-laser pulse corresponds to the time for double traversal of the cavity. Evidence is reported for local saturation of two Ar(II) laser lines in pulsed argon discharges. (auth)

3390 TUNABLE INFRARED PARAMETRIC GENERATION IN CESIUM DIHYDROGEN ARSENATE. Massey, G. A.; Elliott, R. A. (Oregon Graduate Center, Beaverton). IEEE J. Quant. Electron.; QE-10: No. 12, 899-900(Dec 1974).

Parametric generation of near infrared coherent light, tunable over the range 854 to 1410 nm, was obtained in an oscillator using a 3-cm crystal of cesium dihydrogen arsenate (CDA). Pumping was accomplished with 10-ns pulses of 532-nm light from a frequency-doubled Nd:YAG laser. Single-pass parametric gains of the order of 300 were obtained in the crystal. The infrared output pulses typically were 1 ns in duration, with a peak power of approximately 600 kW. (auth)

3391 EXPERIMENTS AND THEORY OF NANOSECOND PULSE EXTRACTION IN AN ATMOSPHERIC PRESSURE CO_2 AMPLIFIER. Girard, G.; Farcy, J. C.; Fertal, A.; Michon, M. (CGE, Marcoussis, France). IEEE J. Quant. Electron.; QE-10: No. 12, 901-906(Dec 1974).

The gain saturation properties of a double discharge CO_2 laser for nanosecond pulses are presented. The results found are in good agreement with those appearing in the literature. (auth)

3392 CW GAIN MEASUREMENTS IN SMALL-BORE ARGON-ION LASER DISCHARGES USING A NOVEL MODULATION TECHNIQUE. Bennett, W. R. Jr.; Sze, R. C. (Yale Univ., New Haven). IEEE J. Quant. Electron.; QE-10: No. 12, 908-910(Dec 1974).

A technique for small-signal gain measurements for cw laser systems is described. The method is applied to the measurement of multimode small-signal gain coefficients of small-bore argon-ion laser transitions. (auth)

3393 OBSERVATIONS OF ANOMALOUS GAIN COEFFICIENTS IN TEA DOUBLE-DISCHARGE CO_2 LASERS. Singer, S. (Los Alamos Scientific Lab., NM). IEEE J. Quant. Electron.; QE-10: No. 11, 829-831(Nov 1974).

Direct measurements of the gain coefficient of a TEA double-discharge CO_2 laser versus wavelength show that while the overall wavelength dependence is in good agreement with that predicted from the model wherein the rotational levels are in thermal equilibrium, P(20) in the 10.4-mu m band and P(22) in the 9.4-mum band have a gain coefficient that is approximately 10 percent high. These results are interpreted as evidence for stimulated emission from "hot bands" by these laser lines. Other transitions in these two bands should also exhibit gain coefficients that have been enhanced to a lesser degree. (auth)

3394 COMPARATIVE STUDY OF DYE PRISM RING LASERS. Marowsky, G. (Max-Planck-Inst. fuer Biophysikalische Chemie, Goettingen, Ger.); Zaraga, F. IEEE J. Quant. Electron.; QE-10: No. 11, 832-837(Nov 1974).

The performance characteristics of several types of flashlamp- and N_2-laser-pumped dye prism ring lasers were investigated. A tuning range covering the whole visible spectrum was observed with bandwidths from 0.5 nm to 0.03 pm. Diffraction-limited output with power level up to 150 kW in multimode operation at high input energies and 2 kW in single-mode operation of the flashlamp-pumped version was obtained in the spectral range of rhodamine 6G. (auth)

3395 SELF-FOCUSING OF VERY POWERFUL LASER BEAMS II. Suydam, B. R. (Los Alamos Scientific Lab., NM). IEEE J. Quant. Electron.; QE-10: No. 11, 837-843(Nov 1974).

In a recent paper the author proposed a self-focusing theory based on linear stability analysis of a quasi-optical equation. Strictly, the theory applies only to a plane wave of infinite aperture. In this paper the theory is extended to beams of finite aperture, which may be initially convergent or divergent. (auth)

3396 PERFORMANCE OF AN HF CHAIN-REACTION LASER WITH HIGH INITIATION EFFICIENCY. Whittier, J. S. (Aerospace Corp., Los Angeles); Kerber, R. L. IEEE J. Quant. Electron.; QE-10: No. 11, 844-847(Nov 1974).

Output-pulse observations are presented for a tranverse electrically initiated, helium-diluted HF laser pumped by the $H_2 + F_2$ chain reaction. Performance of this laser is studied over a wide range of the gas composition and for initial pressures between 0.1 and 0.5 atm. The gas mixture was stabilized by premixing O_2, F_2, and He and flowing this mixture into a cold trap (84°K) before mixing with H_2. Optimum conversion of electrical-initiation energy into laser energy was found for a 240-torr mixture with a mole ratio 1 F_2:0.23 H_2:0.08 O_2:12 He which, when initiated with a 25-kV, 333-pF discharge, gave a pulse energy of 0.150 J. This corresponds to a ratio of laser output energy to electrical input energy of 144 percent. After unnecessary losses are taken into account, this ratio becomes 160 percent. (auth)

3397 RADIATIVE LIFETIMES OF NOBLE-GAS ION-LASER STATES: COLLECTED RESULTS. Donnelly, K. E.; Kindlmann, P. J.; Bennett, W. R. Jr. (Yale Univ., New Haven). IEEE J. Quant. Electron.; QE-10: No. 11, 848-849(Nov 1974).

A summary of measurements of radiative lifetimes for 34 separate upper laser levels in noble-gas ion systems is presented. The technique used is pulsed excitation by threshold-energy electron impact followed by multichannel delayed-coincidence analysis. Results are specifically given for the 3p states of Ne^+, the 4p states of Ar^+, the 5p states of Kr^+, and the 6p states of Xe^+. The errors in measurement range from approximately 2 to 6 percent. (auth)

3398 INFRARED LASER LINES IN ARSENIC VAPOR. Fowles, G. R.; Zuryk, J. A.; Jensen, R. C. (Univ. of Utah, Salt Lake City). IEEE J. Quant. Electron.; QE-10: 11, 849(Nov 1974).

Pulsed discharges in arsenic vapor have produced laser oscillation on a number of wavelengths in the near infrared. The transitions are assigned to the neutral arsenic atom. (auth)

3399 MULTIMODE APPROACH TO THE PHYSICS OF UNSTABLE LASER RESONATORS. Shih, H. (Univ. of Arizona, Tucson); Scully, M. O.; Avizonis, P. V.; Louisell, W. H. Phys. Rev., A; 11: No. 2, 630-647(Feb 1975).

A new approach is presented to the problem of unstable laser resonators. A stable resonator is considered in which a thin diverging lens is inserted near one mirror. By varying the focal length of the lens, the lens-resonator system can go from stable to unstable. The field in the lens-resonator system is expanded in terms of the normal modes of the original stable resonator. The polarization of the lens causes coupling of the stable modes. The present method allows one to introduce the active lasing medium in a natural way, as is shown. The normal modes of

the unstable resonator are obtained numerically, along with analytic solutions in certain limiting cases. A physical discussion of the unstable resonator problem is given in terms of a pseudo-spin picture. (auth)

3400 HIGH-POWER ULTRAVIOLET PARATERPHENYL-SOLUTION LASER EXCITED BY THE PLASMA FOCUS OF A MAGNETOPLASMA COMPRESSOR. Kozlov, N.P.; Alekseev, V.A.; Protasov, Yu.S.; Rubinov, A.N. (N. E. Bauman Technical College). JETP Lett. 20: No. 11, 331-332 (5 Dec 1974).

High-power ultraviolet laser action was obtained in the 339-345 nm range by exciting an ethanol solution of paraterphenyl with a plasma focus of a magnetoplasma compressor in a vacuum $\sim 10^{-6}$ Torr. At 1710 J energy input to the discharge, the lasing energy was 2.6 J and the generated power was 26 MW. (auth)

3401 INJECTION HETEROLASER WITH RADIATION EXTRACTED THROUGH A DIFFRACTION GRATING. Alferov, Z.I.; Gurevich, S.A.; Kazarinov, R.F.; Larionov, V.R.; Mizerov, M.N.; Portnoi, E.L. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). Sov. Phys.-Semicond. 8: No. 10, 1321-1322 (Apr 1975).

We have constructed a semiconductor laser emitting a low divergence beam. The interference photoetching method was used in the formation of a diffraction grating on the waveguide surface.(AIP)

3402 PLASMA DYNAMIC LASERS. Reshetnyak, S.A.; Shelepin, L.A. Sov. Phys.-Tech. Phys. 19: No. 8, 1076-1080 (Feb 1975).

In the rapid expansion of a dense, highly ionized plasma in the plasma laser, the electron gas is cooled, the plasma recombines, and lasing occurs on atomic transitions. A method of calculating these is developed using quasistationary analytic population distribution functions over discrete levels. A quenching effect is considered for a hydrogen plasma and a radiative mechanism for emptying the lower laser level is analyzed. The possibility of an effective collision mechanism for lithium, helium, and beryllium plasmas is pointed out which would permit the use of large plasma volumes for generation. The dependence of population inversion on a number of parameters is studied. (auth)

3403 EFFECT OF PLASMA PARAMETERS ON EMISSION IN AN ION LASER. Sakharov, I.E.; Ermolin, V.V.; Shatalin, S.V. (M. I. Kalinin Leningrad Polytechnic Institute). Sov. Phys.-Tech. Phys. 19: No. 8, 1081-1084 (Feb 1975).

The plasma parameters (electron temperature, density) and the laser emission in a discharge in argon are studied experimentally. The parameter range studied includes a region in which the degree of ionization is near unity. The discharge is produced in a tube 6 mm in diameter and 1 m long in a long-pulse regime (100 μsec) at currents up to 600 A at pressures $2 \cdot 10^{-2}$ to 10^{-1} torr. The high degree of ionization permits observations up to electron temperatures of ~ 20 eV. The pressure range varies from $3 \cdot 10^{14}$ to $1 \cdot 10^{15}$ cm^{-3}. The data yield optimum values of plasma parameters from the standpoint of laser emission. It is proposed that one of the mechanisms which limits the growth of laser emission with discharge current is an instability observed in these experiments. (auth)

3404 THEORETICAL DESCRIPTION OF THE GAS TRANSPORT ELECTRICALLY EXCITED CO_2-N_2-He LASER. Draganescu, V.; Comaniciu, N.; Gutu, I.; Farcas, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 9, 899-904 (1974).

Gas transport electrically excited CO_2-N_2-He laser parameters, like small signal gain, saturation parameter, output power, are computed. The rate equations are used. The gas mixture kinetic temperature in the active zone is determined, thus being able to use the suitable relaxation and transfer rates for the rate equations. A correlation among parameters such as gas speed, pressure, electron density, active-medium volume, gain, gas temperature was obtained. (auth)

Cryogenic and Superconducting Equipment and Devices

Refer also to abstract 4169.

3405 (COM-74-51064) ADVANCES IN THE MEASUREMENT OF RF POWER AND ATTENUATION USING SQUIDS. Final Report, July 1973-June 1974. Kamper, R. A.; Simmonds, M. B.; Adair, R. T.; Hoer, C. A. (National Bureau of Standards, Boulder, Colo. (USA)). Sep 1974. 32p. (NBS-TN-661). GPO.

Stable SQUIDS were developed with preset junctions which survive thermal cycling and mechanical shock. Further work is required to arrive at a version suitable for precise rf measurements. A "breadboard" system was assembled capable of measuring rf power at levels down to 10^{-15} W in the range of frequency from 100 MHz to 1 GHz. The authors have extended the dynamic range of the system to measure rf attenuation to 60 db, and have developed the hardware to partially automate its operation and to accommodate step attenuators. The authors have tested a portable version of this system, and are in process of designing an improved version based on what was learned from the first one. (GRA)

3406 (CONF-710361-) PROCEEDINGS OF THE SPECIAL MEETING ON UNCONVENTIONAL INFRARED DETECTORS, U. S. NAVAL ELECTRONICS LABORATORY, SAN DIEGO, CALIFORNIA, 16 MARCH 1971. Ivory, J. E. (ed.). (Michigan Univ., Ann Arbor (USA). Infrared Information and Analysis Center). Apr 1971. 161p. Univ. of Michigan, Ann Arbor.

Separate abstracts were prepared for 2 of the 13 papers presented. The remaining 11 papers were not within the scope of NSA. (WHK)

For abstracts of individual papers see: 3407 and 3408.

3407 (CONF-710361-, pp 27-42) JOSEPHSON EFFECT FAR-INFRARED DETECTOR. Shapiro, S. (Univ. of Rochester, New York). Apr 1971.

From proceedings on unconventional infrared detectors; San Diego, California, USA (16 Mar 1971).

In proceedings of the special meeting on unconventional infrared detectors, U. S. Naval Electronics Laboratory, San Diego, California, 16 March 1971. (Michigan Univ., Ann Arbor (USA). Infrared Information and Analysis Center).

Four Josephson effect schemes for detection of far-infrared radiation are reviewed: Video broad-band detection, regenerative detection, conventional mixing for monochromatic signals, and self-mixing or frequency conversion. (WHK)

3408 (CONF-710361-, pp 43-48) SUPERINDUCTOR AS AN INFRARED SENSOR. Naugle, D. G.; Porter, W. A. (Texas A and M Univ., College Station). Apr 1971.

From proceedings on unconventional infrared detectors; San Diego, California, USA (16 Mar 1971).

In proceedings of the special meeting on unconventional infrared detectors, U. S. Naval Electronics Laboratory, San Diego, California, 16 March 1971. (Michigan Univ., Ann Arbor (USA). Infrared Information and Analysis Center).

Associated with the kinetic energy of the superconducting electrons in a current carrying superconductor is an effective inductance which increases dramatically as the transition temperature, T/sub c/, is approached from below. Near the transition temperature the value of kinetic inductance, L/sub K/, for a thin superconducting film of suitable geometry for use as an infrared sensor may be of the order of a few microhenrys, considerably larger than the usual inductance, L/sub M/, associated with the energy stored in the magnetic field produced by the current. The abrupt decrease in resistance of a superconducting film, as T/sub c/ is approached from above, has provided the basis for detection of infrared radiation with the superconducting bolometer. It is believed, however, that several advantages may be obtained by observing the change in kinetic inductance of a superconducting film rather than its resistive change due to the temperature deviations produced by the radiation. If the temperature dependence of the kinetic inductance of the superconducting film is to be used to detect infrared radiation, then the "superinductor" which serves as the sensor must be operated below its transition temperature. This eliminates the Johnson noise associated with the resistance of the standard bolometer. The superinductor may be used in an oscillator tank circuit to control the frequency of the oscillator. It is possible to design very stable oscillators and measure very precisely small changes in frequency due to the change in kinetic inductance produced by the incoming radiation. Considering the fact that fabrication of such a sensor should be relatively simple and very inexpensive and its operation rather uncomplicated, it may be advantageous to replace the sensors presently used with a superinductor for many applications. The basis of kinetic inductance is reviewed with such a goal in mind. (WHK)

3409 (CONF-731229-P16A, pp 29-36) LOW TEMPERATURE TECHNIQUES. Sreedhar, A. K. (Solid State Physics Lab., Delhi). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27-31, 1973. Volume 16A.

Low temperature techniques are being increasingly used in basic research. Apart from interest in purely low temperature phenomena such as study of quantum fluids and superconductivity, low temperature techniques are widely used in general investigations in solid state physics. Temperature being one of the basic thermodynamic variables, as study of the properties of materials as a function of temperature is of great importance. Superconducting magnets and other devices based on superconductive phenomena such as bolometers, high "Q" cavities, quantum interference devices etc. are finding increasing use in general investigations. The paper reviews some of the basic techniques of low temperature instrumentation, such as (1) design of cryo-

stats, (2) low temperature thermometry (3) superconducting magnets etc. Some of the work on low temperature instrumentation being done in the laboratory are discussed. (auth)

3410 SUPERCONDUCTING MAGNET FOR MAGNETIC SUSPENSION DEVICE. Saito, R.; Tada, N.; Kimura, I.; Takahashi, T. Hitachi Hyoron; 55: No. 6, 31-35(Jun 1973). (In Japanese).

A magnetic suspension device using a superconducting magnet was constructed and tested. A series of experiments on this device which utilizes magnetic interaction between excited superconducting windings and rotating normal conducting loops proved successful, indicating the possibility of its practical application to the linear motor driven high speed train. (Elec. Electron. Abstr.)

3411 VARIABLE TEMPERATURE APPARATUS USING A THERMAL CONDUCTIVITY MEASUREMENT TECHNIQUE FOR THE DETERMINATION OF SUPERCONDUCTING AC POWER LOSS. McConnell, R.D.; Critchlow, P.R. (Institut de Recherche de l'Hydro-Quebec, C.P. 1000, Varennes, Quebec, Canada). Rev. Sci. Instrum. 46: No. 5, 511-516 (May 1975).

A variable temperature apparatus is described which uses a thermal conductivity measurement technique for the determination of superconducting ac power loss. The technique consists of measuring the increase in temperature of a thermally isolated sample carrying an alternating current. Accurate measurements over a relatively large temperature range are possible. Loss data on a 13 cm long, single filament NbTi superconductor are presented at various temperatures and currents. (auth)

3412 USE OF FLUXOID QUANTIZATION IN THE MEASUREMENT OF THE INDUCTANCE OF SINGLE-JUNCTION SQUIDs. Pei, S.S.; Lukens, J.E. (Department of Physics, State University of New York, Stony Brook, New York 11794). J. Appl. Phys. 46: No. 5, 2257-2260 (May 1975).

Calculations of the change in the flux linking a superconducting ring when a change in the fluxoid quantum state is induced are presented, taking into account the effect of thermodynamic fluctuation on the transition. A method is described by which this calculated flux value can be used to provide a calibration in a measurement of the inductance of the ring. The measurement procedure described is useful for rings with an inductance of 10^{-8} H and smaller, and will give results accurate to about 2%. (auth)

3413 LOW NOISE PARAMETRIC UPCONVERSION WITH A SELF-PUMPED JOSEPHSON JUNCTION. Kanter, H. (Electronics Research Laboratory, The Aerospace Corporation, Los Angeles, California 90009). J. Appl. Phys. 46: No. 5, 2261-2263 (May 1975).

Experimental results are reported on a Josephson parametric upconverting amplifier which is self-pumped via the internal Josephson oscillations derived from a dc bias voltage. A niobium point-contact SQUID is simultaneously coupled to a 115-MHz tank circuit and a 9-GHz cavity. Josephson oscillations at 9 GHz produce parametric upconversion of power in the 115-MHz circuit to sidebands at 9 ± 0.115 GHz with measured power gain of 25. The amplifier noise temperature, referred to the input at 115 MHz, was established to be < 15 K by varying the temperature of an input termination from 4.2 to 300 K. This result establishes the behavior of self-pumped SQUID upconverters at microwave frequencies and demonstrates that the achievable noise performance is not greatly in excess of the thermal limit. (auth)

3414 * COUPLING CONSIDERATIONS FOR SQUID DEVICES. Claassen, J.H. (School of Applied and Engineering Physics, and Laboratory for Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853). J. Appl. Phys. 46: No. 5, 2268-2275 (May 1975).

Most applications of superconducting quantum interference devices (SQUID's) involve use of a coupling coil. There are two classes of such applications: magnetometry (magnetic field, field gradient) and voltage or current measurements. We have analyzed the factors which determine the ultimate sensitivity, and present a guide for optimization of signal/noise in each of the two cases. It is found that a single figure of merit, involving both the equivalent input noise of the SQUID and the effectiveness of the coupling to the coil, is applicable to either type of measurement. We propose that this figure of merit be used in evaluating the performance of new SQUID designs. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 3291, 5395, 5410, 5642, 5702, and 5704.

3415 (COO-2152-16) APPLICABILITY OF THE HOMOGENEOUS FLOW MODEL TO PRESSURE DROP IN STRAIGHT PIPE AND ACROSS AREA CHANGES. Husain, A.; Choe, W. G.; Weisman, J. (Cincinnati Univ., Ohio (USA)). 1974. 50p. Dep. NTIS $5.50.

This study was undertaken to evaluate systematically the conditions under which the homogeneous model may be applied to prediction of frictional two-phase pressure drop in straight pipes and abrupt area changes. The approach taken was first to examine the available observations on flow pattern transitions. On the basis of the observations in the literature, as well as additional observations made with the Freon-Freon vapor system, a simple criterion for the existence of homogeneous flow was established. The homogeneous model was then compared to the available pressure drop data in the region where it could be considered applicable. It was concluded that the data on pressure drop across abrupt area changes are reasonably consistent with the predicted transition to homogeneous flow in straight pipes. Although contraction pressure drop may be approximated by the homogeneous model over a wide velocity range, the model should only be used for expansion pressure drops at very high mass flow rates. Any further studies of the inter-relationship of flow pattern and area change pressure drop will require void fraction-quality relationships which consider flow patterns. (LCL)

3416 (WANL-TME-1144) TECHNIQUES FOR MEASURING THE QUALITY OF HIGH TEMPERATURE POTASSIUM VAPOR. Steam Test Plan. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 15 Apr 1965. 29p. Dep. NTIS $4.50.

The steam test program plan for a steam check of the potassium calorimeter performance is presented. The purpose of the steam test was to achieve the following goals using a fluid which is simpler to control than alkali metal vapor: design checkout and instrument performance; determination of modifications required to achieve the desired accuracy within 2% for a vapor quality range of 80 to 95%; and within ½% for a vapor quality range of 95 to 100%; determination of the effect of miniaturization of designs suitable for individual probes in confined spaces; and gain test experience with the devices for application in the potassium tests to be performed at ORNL. (auth)

3417 IMPROVEMENTS IN OR RELATING TO FLUID FLOW CONTROL VALVES. Sheldon, W. J.; Gaylard, B. (to Burnden Park Engineering Co. Ltd.). British Patent 1,372,361/B/. 30 Oct 1974. Filed Date 29 Oct 1970. 11p.

Reference is made to valves controlling fluid flow, such as those used in UF_6 plants. It is stated that valves used hitherto in such plants have suffered from sealing problems due to the need to transmit mechanical operation through the valve casing. The valve described is electromagnetically operated and has a valve member within the housing that cooperates with a seating to control fluid flow between inlet and outlet. Spring means are provided to apply force to the valve member, together with electromagnetic means to move the member against the spring force. The electromagnetic means comprises a magnetizable member movable in the housing relative to an external winding. Several alternative arrangements of the system are described. (UK)

3418 EVALUATION OF MICROLAYER CONTRIBUTION TO BUBBLE GROWTH IN NUCLEATE POOL BOILING USING A NEW BUBBLE GROWTH MODEL. Saini, J. S.; Gupta, C. P.; Lal, S. (Univ. of Roorkee, India). Int. J. Heat Mass Transfer, 18: No. 3, 469-472(Mar 1975).

A new bubble growth model is considered in which the shape of the growing bubble is represented by a spherical segment of which both the radius of the base in contact with the heating surface, and the vertical height above the base vary with time. A general expression is derived for initial microlayer thickness. The results for bubble growth curves obtained on the basis of the assumption of "infinitely thick microlayer" are in satisfactory agreement with experimental results. (UK)

3419 BUBBLE GROWTH RATES IN PURE AND BINARY SYSTEMS. Combined Effect of Relaxation and Evaporation Microlayers. van Stralen, S. J. D.; Sohal, M. S.; Cole, R.; Sluyter, W. M. (Technische Hogeschool, Eindhoven, Netherlands). Int. J. Heat Mass Transfer, 18: No. 3, 453-467(Mar 1975).

Pohlhausen's equation has been used to determine the initial thickness of the evaporating microlayer beneath a hemispherical vapor bubble on a superheated horizontal wall. Microlayer thickness is proportional to the square root of the distance to the nucleation site during early bubble growth, while a linear relationship exists during advanced growth. A heat and mass diffusion-type solution is derived for advanced bubble growth, which accounts for the interaction of the mutually dependent contributions due to the relaxation microlayer (around the bubble dome) and the evaporation microlayer. The entire bubble behavior during adherence is determined by a combination of this asymptotic solution and the Rayleigh solution, which governs early growth. Expressions are also derived for both the radius of the dry area and the radius of the maximum contact area between bubble and wall. At low concentrations of the more volatile component in binary systems, the dominating influence of mass diffusion is demonstrated by the following effects: asymptotic bubble growth

is slowed down substantially; the formation of dry areas beneath bubbles is prevented, even at subatmospheric pressures; the lower part of the bubble is contracted; and the evaporation microlayer contribution to bubble growth is negligible at atmospheric and at elevated pressures. (auth)

3420 EFFECT OF JAKOB NUMBER ON FORCES CONTROLLING BUBBLE DEPARTURE IN NUCLEATE POOL BOILING. Saini, J. S.; Gupta, C. P.; Lal, S. (Univ. of Roorkee, India). Int. J. Heat Mass Transfer; 18: No. 3, 472-474(Mar 1975).

A quantitative determination was made to obtain the Jakob number ranges over which the surface tension force and inertia forces control, respectively, the process of bubble departure. A theoretical analysis is presented of the forces acting on the bubble. Using experimental bubble growth data these forces were computed and plotted as a function of Jakob number and of experimental bubble departure. Equations were derived which satisfactorily predict bubble departure diameters for approximate Jakob numbers < 16, > 100, or for intermediate values respectively. (UK)

3421 FORCED CONVECTION HEAT TRANSFER TO LIQUID HELIUM I IN THE NUCLEATE BOILING REGION. Keilin, V. E.; Kovalev, I. A.; Likov, V. V.; Pozvonkov, M. M. (Moscow State Inst. of Atomic Energy). Cryogenics; 15: No. 3, 141-145(Mar 1975).

Heat transfer and critical heat fluxes to helium boiling in a 2mm id copper tube (100mm long) were measured in the pressure range 1.1 to 1.5 atm and at mass velocities 18 to 96 kg $m^{-2}s^{-1}$. Corresponding Reynolds numbers are (1.2 to 6.2) × 10^4. Experimentally obtained heat transfer coefficients show satisfactory agreement with those calculated according to the Kutateladze equation but with less pronounced pressure dependence. It was found that in the boiling region developed quality did not influence the heat transfer coefficient. An expression was obtained, which describes with ± 10% error, the dependence of critical heat flux on mass flow rate in the pressure range 1.1 to 1.5 atm and mass quality 0.33 to 0.6. (auth)

3422 HEAT TRANSFER IN CRYOGENIC LIQUIDS UNDER PRESSURE. Bewilogua, L.; Knoener, R.; Vinzelberg, H. (Technische Univ., Dresden). Cryogenics; 15: No. 3, 121-125(Mar 1975).

The dependence of the heat transfer on pressure is studied for a horizontal plane surface in liquid helium, liquid hydrogen, and liquid nitrogen in the range $0.03 < p/p_c < 0.9$: a maximum of the maximum heat flux density $\dot{q}_{m,m}$ was found at $\sim 0.35 p_c$. For helium, additionally, the dependence on the inclination of the surface against the horizontal was determined. A general representation for the dependence of the reduced maximum heat flux density $\dot{q}_m/\dot{q}_{m,m}$ on the reduced pressure p/p_c is given which also describes adequately well the results obtained with other cryogenic liquids. (auth)

3423 EFFECT OF JAKOB NUMBER ON FORCES CONTROLLING BUBBLE DEPARTURE IN NUCLEATE POOL BOILING. Saini, J. S.; Gupta, C. P.; Lal, S. (Univ. of Roorkee, India). Int. J. Heat Mass Transfer.; 18: No. 3, 472-475(Mar 1975).

It is well known that at low values of Jakob number (N_{Ja}) the bubble growth rates and departure diameters are small and bubble departure is controlled primarily by the surface tension force, the inertia (drag and liquid inertia) forces being relatively small. At high values of Jakob number, on the other hand, the growth rates and departure diameters are large and inertia forces control bubble departure. Theoretical studies were undertaken to obtain quantitatively the Jakob number ranges over which the surface tension force and inertia forces control, respectively, the process of bubble departure. The calculated results are compared with results computed using experimental bubble growth data. It was concluded that the bubble departure diameter could be predicted satisfactorily for $N_{Ja} < 16$ (approx.) or $N_{Ja} > 100$ (approx.). (LCL)

3424 EVALUATION OF MICROLAYER CONTRIBUTION TO BUBBLE GROWTH IN NUCLEATE POOL BOILING USING A NEW BUBBLE GROWTH MODEL. Saini, J. S.; Gupta, C. P.; Lal, S. (Univ. of Roorkee, India). Int. J. Heat Mass Transfer; 18: No. 3, 469-472(Mar 1975).

Recent theories of bubble growth in nucleate pool boiling postulate that a major portion of heat transfer to the bubble occurs by conduction through a liquid microlayer formed on the heated surface. It is therefore important that the base contact area of the bubble, through which heat is transferred, is accurately accounted for. For this purpose, a new bubble growth model is considered. In this model, the shape of a growing bubble is represented by a spherical segment of which both the radius of the base in contact with the heating surface, R_1, and the vertical height above the base, H, vary with time (τ). The results obtained using this model are compared with results from previous theories and from experiments. It was concluded that: it appears more appropriate to assume that the bubble shape is represented by a spherical segment characterized by the base radius R_1 and the vertical height H; a general expression has been developed for initial microlayer thickness; and the bubble growth curves obtained on the basis of the assumption of "infinitely thick microlayer," i.e., $k_s \rho_s Cp_s = k_L \rho_L Cp_L$ are in satisfactory agreement with experimental results. (LCL)

3425 HYDRAULIC RESISTANCE IN CHANNELS WITH SURFACE BOILING. Knyazev, V. A. At. Energ. (USSR); 38: No. 1, 16-19(Jan 1975). (In Russian).

Perturbed turbulent flow in a channel is examined. Viscous, turbulent and eddy stress is superimposed if one assumes that pulsating perturbed and turbulent motions are non-correlative. The effective viscosity of surface boiling is evaluated and the local hydraulic resistance coefficient calculated. The results are compared with experimental data. (auth)

3426 MEASUREMENT OF SPECIFIC HEATS AT LOW TEMPERATURE BY AN ADIABATIC TECHNIQUE. Hall, R. A. O.; Lee, J. A.; Mortimer, M. J.; Sutcliffe, P. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Cryogenics; 15: No. 3, 129-134(Mar 1975).

An apparatus is described for the measurement of specific heats, by an adiabatic technique, from liquid helium to room temperature. The method is particularly applicable to radioactive samples where the heat generation due to decay within the specimen may be very large. The adiabatic shield, which surrounds the sample, is automatically regulated to the same temperature as the specimen, which may be heating at 20°K min^{-1}. The apparatus is automated such that all data is read out in a form suitable for computer handling. (auth)

3427 MOMENTUM LOSSES AND CONVECTIVE HEAT TRANSFER IN ROD BUNDLES: AN OVERVIEW. Lewis, M. J.; Buettiker, P. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nucl. Eng. Des.; 31: No. 3, 351-362(1974).

A critical survey is made of the prediction methods available for analysing the momentum and heat transfer characteristics of axial flow in a clustered rod bundle. The Navier-Stokes and energy equations are presented, their solution procedure is outlined and the boundary layer approximation discussed. Four levels of approximation to these equations, namely, slug flow, integral methods, eddy diffusivity, and turbulence energy models are examined and their limitations presented for a simple situation. Consideration is then given to the problem of extending these models to more complex situations such as variable property flows, rough surfaces and flow blockages. (auth)

3428 CALCULATED HEAT TRANSFER DEVELOPMENT IN BUNDLES. Vonka, V.; Boonstra, B. H. (Stichting Reactor Centrum Nederland, Petten). Nucl. Eng. Des.; 31: No. 3, 337-345 (1974).

In many cases heat transfer in rod bundles can be considered as a superposition of several simple heat transports. A number of practical problems can thus be solved if solutions for these elementary transports are available. Two elementary heat transports in rod bundle geometry are investigated, namely the transport from a fuel rod surface into the adjacent subchannel and the transport from one subchannel into the next one. The first transport is characterized in terms of the Nusselt or Stanton numbers, while the latter in terms of the Stanton gap number or mixing factor. Hydraulically developed flow is assumed, with no feedback of heat transport on the flow condition. A three-dimensional numerical calculation by means of the finite difference method is applied to determine the eigenvalue solution of the response on a step change in heating for both cases. The method is tested on an internally heated concentrical annulus. The result is compared with available experimental and theoretical predictions. It is found that the heat transfer between subchannels is developed considerably slower in comparison with the development of the heat transport from fuel rod to subchannel. (auth)

Materials Testing

3429 (RT/ING-(74)36) REVIEW OF NUCLEAR METHODS OF TECHNOLOGICAL ANALYSIS. Sciuti, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Dec 1974. 233p. (In Italian). Dep. NTIS (US Sales Only) $14.75.

A review is presented of the principal nuclear nondestructive testing methods nowadays used with particular emphasis to movable and/or portable equipments. Particular techniques such as neutron radiography and x-ray fluorescence analysis are described. (auth)

3430 (WANL-TMI-1819) FLEXURE TEST OF THIN WALL TUBING. Brickman, E. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 Jul 1967. 7p. Dep. NTIS $4.00.

Several samples of thin wall (0.010 in. and 0.005 in.) Inconel 625 tubing were tested in flexure to determine the buckling strength of the tubing. The specimens were subjected to a third-point flexural loading. Dimensional checks of the specimens showed variations in the OD and wall thickness along the length of the specimens. Using the flexure formula and measured dimensions, the average buckling stress for the 0.010 in. wall tubes was 119,600 psi and for the 0.005 in. wall was 117,700 psi. For both size tubes, tensile yielding occurred before compressive crippling; however, the 0.010 in. wall tube specimens sustained deflection before crippling actually occurred. (auth)

3431 (Y-1983) ULTRASONIC INSPECTION FOR LACK OF PENETRATION AND POROSITY IN A TUNGSTEN INERT GAS WELD WITH A STEP GEOMETRY. Moyer, M. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 21 May 1975. Contract W-7405-eng-26. 24p. Dep. NTIS $4.00.

Ultrasonic techniques were used to certify the penetration and porosity in three structural welds in Type AM 363 stainless steel. A normal beam technique detects a lack of penetration after the root-fusion weld pass. Shear-wave, angled-beam immersion techniques are used after the filler pass to detect any lack of penetration that is as large as 0.5 mm and porosity ranging in size from 0.5 to 1.3 mm. (auth)

3432 GAMMA RADIOGRAPHY USING SHORT HALF-LIFE RADIOISOTOPES. Birchall, I.; Brown, C. B.; Knowles, S. B. (Univ. of Liverpool). Int. J. Appl. Radiat. Isotop.; 26: No. 3, 141-145(Mar 1975).

A feasibility study has been undertaken to determine the possibilities of short half-life isotopes produced in a university reactor being used for the radiography needs within the university. The parameters considered, in a comparison with commercially available sources, were activity, γ energy, source size and half-life. These data for ^{56}Mn, ^{64}Cu and ^{187}W are compared in tabular form. The design of the necessary equipment is discussed. (UK)

3433 PHOTON ACTIVATION OF ALLOYS AND ELEMENTS USED IN INDUSTRIAL PARTS REQUIRING HIGH-ENERGY X-RAY RADIOGRAPHY. Kuttemperoor, V. Z. (Milwaukee School of Engineering). Mater. Eval.; 33: No. 5, 113-119(May 1975).

It was pointed out previously that the radioactivity induced in materials radiographed using a 25 MeV betatron presents a potential health hazard to persons working with such activated materials and others who accidentally come in contact with them. Radiation analyses of alloys and elements not discussed previously are presented. More specifically, decay rates and nuclear spectra of a number of alloys and elements are presented in addition to the induced radiation levels observed in a typical industrial part exposed to high energy x rays under radiography conditions. The creation of a number of radioactive isotopes having both short and long half-lives has been verified by energy and half-life measurements. Some of the isotopes identified include ^{11}C, ^{28}Al, ^{29}Al, ^{49}Cr, ^{51}Cr, ^{56}Mn, ^{52}Fe, ^{57}Ni, ^{61}Co, ^{61}Cu, ^{62}Cu, ^{64}Cu, ^{65}Zn, ^{69}Zn, ^{108}Ag, and ^{110}Ag. The results presented in this paper can be applied to situations in which the alloys and elements studied here are present in industrial parts that require high-energy x-ray radiography so as to minimize the radiation exposure of persons handling such activated materials. (auth)

3434 ACOUSTIC EMISSION CONVERTERS FOR QUALITY CONTROL OF WELDED JOINTS. Leskov, G. I.; Trunov, E. N.; Zhivaga, L. I. (AN Ukrainskoi SSR, Kiev. Inst. Ehlektrosvarki). Svar. Proizv.; No. 7, 38-39(Jul 1974). (In Russian).

For English translation see the journal Weld. Prod.

A description is given of piezoelectric and electromagnetic converters of acoustic emissions which occur in weld seams with crack formation. By means of the acoustic emissions which are converted to electrical oscillations that are transmitted to the inlet of recording instrumentation, it is possible to judge the quality of welded joints, the proper modes of procedure, and the welding technology. (tr-SJR)

Nuclear Explosions

Refer also to abstracts 3301, 3444, and 3617.

3435 (NVO-86(Rev.5)) REPORTS AVAILABLE IN PLOWSHARE OPEN FILE. (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Apr 1975. 49p. Dep. NTIS $5.50.

A significant compilation of scientific and technical information has resulted from Projects Gasbuggy, Rulison, Rio Blanco, and Wagon Wheel, all of which were conceived within the framework of the U. S. Atomic Energy Commission's Plowshare Program to develop peaceful uses for nuclear explosives (PNE). The fundamental concept in these underground engineering applications is to use the energy of a deeply buried nuclear explosive to increase the permeability and porosity of rock, thereby stimulating the flow of natural gas. A list of those publications concerning Gasbuggy, Rulison, Rio Blanco, and Wagon Wheel that have been placed in the Plowshare Open Files by the Nevada Operations Office is presented. All of these publications are available to the scientific, technical, and industrial communities, including several reports on massive hydraulic fracturing. High-volume hydraulic fracturing methods are under investigation as a supplement or an alternative to extensive nuclear stimulation. Also listed in this document under General Reference Information are certain other publications concerning safety programs for underground nuclear detonations which may be of particular interest. (auth)

3436 (SAND-74-5836) TRANSPORTABLE 56-kN, 200-mm DISPLACEMENT HYDRAULIC SHAKER FOR SEISMIC SIMULATION. Smallwood, D. O.; Hunter, N. F. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1972. 11p. (CONF-750402-2). Dep. NTIS $4.00.

From 21st annual meeting of the Institute of Environmental Sciences; Anaheim, California, USA (13 Apr 1975).

A large hydraulic shaker for seismic simulation is described. The shaker is 6.1 x 2.2 x 0.8 m and weighs 8800 kg. The shaker has a 56-kN force output driving a 7000 kg reaction mass, with a maximum displacement capability of 200 mm (p-p) over a frequency range from 1 to 50 Hz. The entire system, including the hydraulic power supplies, is designed to be self-contained and transportable. External support required for the system includes 110-V power for instrumentation, 64-kV . A (220- or 440-V) power for the hydraulic power supplies, and water for oil cooling. The system was successfully used to excite a four-story test structure at the AEC's Nevada Test Site. A brief description of the test series is given. (auth)

3437 (UCID-16719) ROCK MODELING IN TENSOR74, A TWO-DIMENSIONAL LAGRANGIAN SHOCK PROPAGATION CODE. Burton, D. E.; Schatz, J. F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Mar 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.25.

TENSOR74 is a major revision of TENSOR, a computer code designed to solve stress wave propagation problems in two dimensions. The major physics modifications in TENSOR74 are in the area of constitutive modeling of solid materials. The new models, which are described in detail, take into account pore collapse, ductile and strain softening brittle failure, as well as tensile failure with void opening and closure. In addition, a modified form of linear artificial viscosity is described. (auth)

3438 PEACEFUL NUCLEAR EXPLOSIONS. A Survey of Indian Experiments and Perspective for India Possibilities of Application. Izotoptechnika; 18: No. 1, 35-40(Jan 1975). (In Hungarian).

3439 REDUCED FALSE ALARM RATES IN SEISMIC ARRAY DETECTION BY NON-LINEAR BEAMFORMING. Weichert, D.H. (Seismology Division, Earth Physics Branch, Department of Energy, Mines and Resources, Ottawa K1A OE4, Canada). Geophys. Res. Lett. 2: No. 4, 121-123 (Apr 1975).

It has been suggested that a nonlinear, multi-channel summation process increases the signal-to-noise ratio of small coherent signals. Using the data base of the International Seismic Month, it is shown conclusively that a logarithmic beamforming process increases the detection probability for seismic events for a specified false alarm rate by at least a factor of two. A detector based on this process is working on-line at the Yellowknife seismic array. (auth)

Protective Structures and Equipment

Refer also to abstracts 3158, 3159, 5315, 5316, 5352–5354, 5411, 5677, 5679–5684, 5686–5690, and 5692.

3440 (CONF-731218-P1, pp 483-488) EXPERIENCE WITH IODINE FILTERS IN THE PRODUCTION OF IODINE TAGGED COMPOUNDS ON THE CURIE SCALE. Schulze-Pillot, G. (Farbwerke Hoechst AG, Frankfurt am Main). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

During the production of iodine tagged compounds, iodine is released in the form of pure iodine, iodide and organic compounds. The order of activity concentration in the treated solutions used is Ci/ml and the amount of radioactive material released can be as high as 100 mCi. This may all be released instantaneously or

over periods of up to one hour. The work is carried out in cells from which the exhaust air passes over activated charcoal iodine filters at two levels. Under operating conditions the decontamination factor of the two-level filtering measured over a period of 24 hours lies between 10^4 and 10^5. This figure is lower than expected from the retention efficiency of each individual filter. The retention efficiency as a function of the time after release of the radioactive substance was therefore also measured. (auth)

3441 (CONF-731218-P1, pp 489-502) EXPERIENCE WITH IODINE SORPTION UNITS AT THE CEN/SCK. Fieuw, G.; Boulenger, R. (CEN, Mol, Belg.). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

At the C.E.N./S.C.K. the air in the cells where ^{131}I is produced from irradiated tellurium oxide passes through activated charcoal filters before it is released into the atmosphere. The efficiency of the filters is checked at regular intervals, and the ^{131}I release in the stack is monitored continuously. The ventilation system has a flow-rate of 400 m^3 per hour and the iodine concentrations upstream of the filter are of the order of 10^{-10} g $\cdot m^{-3}$. The minimum retention efficiency is 95%. Checking methods and results are described and discussed. (auth)

Safety Engineering

Refer also to abstract 3292.

3442 (FZK-164) FIRE-INCIDENT AND DAMAGE REPORT OF 30 MARCH 1963 MATERIALS EVALUATION EXPERIMENT IN THE NARF GTR RADIATION EFFECTS TESTING SYSTEM. (General Dynamics/Fort Worth, Tex. (USA)). 14 Jun 1963. 99p. Dep. NTIS $8.00.

Prepared for Aerojet-General Corp., Azusa, CA.

A series of experiments was performed on various selected materials in a combined low-temperature (liquid hydrogen) and nuclear radiation environment. After approximately ten hours of operation of the second experiment in this series, a fire broke out in the Ground Test Reactor pool and the experiment was terminated. Facts pertinent to the incident, probable causes, proposed steps necessary to preclude recurrence, and the responsibilities of General Dynamics and of Aerojet-General in connection with the conduct of the test program are discussed. (auth)

3443 (TID/SNA-1636) HYDROGEN SAFETY. Annual Report for the Period January 1–December 31, 1964 (Progress Report No. 4). Van Meter, R. A.; Liebman, I.; Litchfield, E. L.; Zabetakis, M. G. (Bureau of Mines, Pittsburgh, Pa. (USA)). Jan 1965. 48p. Dep. NTIS $5.50.

Progress in studies of safety during the production, handling and use of hydrogen is reported. Information is included on: existing practices; research needed for developing new information; and the compilation of a safety manual for operations involving hydrogen. (LCL)

3444 FIND SAFE PIPE SPANS FOR SEISMIC CONDITIONS. Shah, A. A. Power (N. Y.); 119: No. 5, 74-75(May 1975).

The maximum safe span between supports for nuclear piping is determined by load factors, including the seismic load that could be experienced during an earthquake. Methods for calculating the safe span are presented, and tabulated data to be used in such calculations are presented for various pipe and support conditions. (LCL)

Vacuum Engineering

3445 (CONF-731229–P16A, pp 37-65) ROLE OF ULTRA-HIGH VACUUM TECHNIQUES IN BASIC RESEARCH. Gopalaraman, C. P. (Bhabha Atomic Research Centre, Trombay, India). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27–31, 1973. Volume 16A.

This review is concerned with instruments and methods for basic research utilizing ultrahigh vacuum (uhv:pressures 10^{-9} torr)techniques. Important kinetic data of the vacuum environment and the related physical phenomena are illustrated. The scope and potentialities of uhv are discussed. In recent years the ability to generate, maintain and measure ultrahigh vacua has opened up a major activity in the field of science of surfaces (fifth state of matter). The investigations reveal newer information mainly on the structure and composition of surfaces. The basic principles, main applications and limitations of these sophisticated instruments are summarized. The techniques used involve the interaction of radiation or particle-beams with surfaces, the interaction of charged particles in gas phase and the electrostatic field at surfaces, in controlled environments. Two of the instruments are dealt with in greater detail. Analysis of surfaces by Auger electron spectroscopy (AES) and its capabilities in the determination of chemical composition coverage, work function, charge transfer in bonding, electron energy levels in surface bonds etc. are discussed. A "trapped ion source mass spectrometer" based on uhv techniques, for the efficient production of multiply charged ions, and determination of ionization cross sections, metastable levels and ionization potentials of higher charge states are described. In conclusion, some problems which are yet to be solved before most of these instruments are used for routine analysis are mentioned. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

3446 (AEC-RID-3) THORIUM AND RARE EARTH RESOURCES OF THE LEMHI PASS AREA, IDAHO AND MONTANA. Sharp, B. J.; Hetland, D. L. (USAEC Grand Junction Office, Colo.). Jul 1968. 16p. GJO.

The U. S. Atomic Energy Commission examined about 100 prospects in the Lemhi Pass thorium area of Idaho and Montana during 1965 and 1966. Over 200 samples were collected, and field reconnaissance expanded the already known trend over a total distance of about 70 miles. The thorium veins fill faults in the Precambrian Belt Series. The faulting and vein development are considered to be Tertiary in age. Extensive Tertiary volcanics and lacustrine sediments were deposited after the formation of the veins. The tabular, steeply dipping veins extend for considerable distances in both strike and dip. Ore minerals include phosphatic thorite, monazite, and rare-earth concentrations. The rare earth to thorium ratio varies from 10:1 to 1:5. Exploration consists mainly of bulldozer cuts with one adit and several drill holes. (auth)

3447 (AEC-RPD-13) FINAL TABULATION OF SULFUR-ISOTOPE ANALYSES. (USAEC Grand Junction Office, Colo. Resource Div.). Nov 1971. 76p. GJO.

Uranium host rocks commonly contain two or more types of sulfides differing in mineral species, crystal size or habit, firmness of attachment to detrital grains, or other parameters. It may be assumed that different types of sulfides may have formed at different times and under different conditions and may thus differ in isotopic composition. Since no method of concentration is 100 percent effective, it is likely that different methods (flotation, heavy liquids, sieving, etc.) should preferentially concentrate one type or another in relation to one or more of these parameters and thus to isotopic composition of sulfur. It has been found, however, that variations in isotopic composition of splits of concentrates carefully prepared to be as nearly identical as possible tend to obscure any differences due to possible selectivity of preparation methods. Pairs of sulfide-concentrate samples prepared from the same field sample are listed in the tabulation, along with brief statements of preparation methods. These results suggest that differences (here considered to be a combination of analytical and sampling error) between supposedly identical samples are large enough to obscure all but the greatest differences due to sample preparation and that the isotopic composition of sulfur in disseminated sulfides of no rock sample represented by this tabulation is known within about two permil. Fractions prepared from the same field sample by highly selective methods, such as hand picking, showed considerable differences. (auth)

3448 (AED-CONF-74-600-006) URANIUM PROCUREMENT. Gilchrist, W. M. (Eldorado Nuclear Ltd., Ottawa, Ontario (Canada)). 1974. 8p. INIS.

From symposium on natural uranium supply; Mainz, F. R. Germany (18 Nov 1974).

The lecture deals with the uranium supply situation as seen by an uranium producer. Accordingly, the supply can only then be ensured if the uranium search and production is planned and financed in time. Looking ahead, more consideration will be given to uranium ore with lower U content than at present. (GE)

3449 (AED-CONF-74-600-008) THE DEPOSITS AND RESERVES OF URANIUM. Dahlkamp, F. J. (Uranerzbergbau G.m.b.H. und Co. K. G., Bonn (F. R. Germany)). 1974. 27p. (In Germar.). INIS.

From symposium on natural uranium supply; Mainz, F. R. Germany (18 Nov 1974).

The characteristics of 6 types of deposits are described into which the presently known uranium resources can be divided: conglomerates, sandstones, gangue, veins, intermagmatic mineralizations and calcretes. Furthermore, the extent of the reserves, ore contents and global distributions are given. The relation of uranium deposits and geochronology is examined. A look is also taken at the future reserves and cost development. (GE)

3450 (CONF-750219-1) SEARCH FOR URANIUM: A PERSPECTIVE. Grutt, E. W. Jr. (Energy Research and Development Administration, Grand Junction, Colo. (USA). Grand Junction Office). 1975. 23p. Dep. NTIS $4.25.

From national western mining conference; Denver, Colorado, USA (7 Feb 1975).

The history of uranium mining in the USA is reviewed. It is postulated that some two million tons of U_3O_8 will be needed to provide fuel for US nuclear power plants through the year 2000. World resources of U ores are reviewed. The functions of the ERDA National Uranium Resources Evaluation Program (NURE), including aerial surveying, in relation to the assessment of potential uranium reserves in the USA are discussed. The scope of ERDA research and development programs are briefly reviewed. (CH)

3451 (DAO-4-TM-3) URANIUM AND THORIUM OCCURRENCES AT THE MONTE CRISTO PROSPECT, EL PASO COUNTY, TEXAS. Sharps, T. I. (USAEC Division of Raw Materials, Denver, Colo. Denver Exploration Branch). 14 May 1957. 11p. GJO.

Uranium and thorium occur at the Monte Cristo Prospect located on the east flank of the Franklin Mountains in El Paso County, Texas. The uranium and thorium minerals are localized in pods along fracture zones in post-Carboniferous granite and pegmatite. It is believed that they were deposited by high temperature hydrothermal solutions. Field evidence obtained from mapping and sampling the mineralized zones indicates that a relatively small tonnage of thorium and uranium ore is present on the property. (auth)

3452 (DEB-3-TM-30) AIRBORNE AND GROUND RECONNAISSANCE IN THE DENVER BASIN, COLORADO. Brown, L. J.; Stehle, F. T. (USAEC Division of Raw Materials, Denver, Colo. Denver Exploration Branch). 9 Jan 1956. 11p. GJO.

Ground and aerial reconnaissance for uranium in the Denver Basin, Colorado, during 1955 resulted in the location of four anomalies, none of which contained ore-grade material. These anomalies were all in the Dawson arkose formation (Tertiary). Additional aerial reconnaissance is recommended to complete the project. Geochemical methods may prove to be valuable exploratory tools in certain areas where high radioactive background counts were encountered. (auth)

3453 (DRM-RO-TM-2(Rev.)) PRELIMINARY REPORT ON HYDROGEOCHEMICAL EXPLORATION IN THE MT. SPOKANE AREA, WASHINGTON. Ilisley, C. T. (USAEC Division of Raw Materials, Denver, Colo. Denver Exploration Branch). Mar 1957. 19p. GJO.

Hydrogeochemical exploration for uranium ore deposits has proved relatively successful. The basic principle involved is that natural waters can dissolve and transport uranium from uranium mineral concentrations in the rocks of the earth crust, and systematic sampling and chemical analyses of ground and surface waters can be used to detect uranium-bearing waters and to trace the anomalies upstream to the source. Results are reported from an investigation of the applicability of hydrogeochemical prospecting for uranium in the Mt. Spokane area in eastern Washington about 30 miles from the city of Spokane. Uranium ore is being shipped from two open-pit mines in the area. A mobile geochemical laboratory was used for uranium determinations on water samples and samples of stream sediments and the results of uranium determinations were plotted on the stream map of the area. Preliminary results indicated that hydrogeochemical exploration for uranium is a valuable tool. (CH)

3454 (ERDA-24) SURVEY OF UNITED STATES URANIUM MARKETING ACTIVITY. Knutson, E. G. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Production and Materials Management). Apr 1975. 28p. Dep. NTIS $4.00.

Results from a survey made to gather information on uranium marketing in the U. S. during 1974 are given. Information was requested from the 70 utilities with reactor projects, 5 reactor manufacturers, and 25 uranium producers or companies with definite plans for future uranium production. (LK)

3455 (GJO-103(75)) URANIUM EXPLORATION EXPENDITURES IN 1974 AND PLANS FOR 1975-76. (Energy Research and Development Administration, Grand Junction, Colo. (USA). Grand Junction Office). 25 Apr 1975. 13p. Dep. NTIS $4.00.

Plans for domestic and foreign uranium exploration during 1975 and 1976 are compared with expenditures for exploration during 1974. (CH)

3456 (GJO-1631-1) AIRBORNE GEOPHYSICAL SURVEY, WIND RIVER BASIN AREA, WYOMING. (Texas Instruments, Inc., Dallas (USA)). 1974. Contract AT(05-1)-1631. 95p. Dep. NTIS $7.75.

Results are reported of AEC-sponsored, high sensitivity, reconnaisance airborne gamma-ray survey of the Wind River Basin area, Wyoming. The objective of the survey was to define those areas showing surface indications of a generally higher uranium content (uraniferous provinces) and where detailed exploration for uranium would most likely be successful. For the data collection tasks, a TI high sensitivity gamma-ray system consisting of seven large-volume NaI detectors, two 400-channel analyzers, and ancillary geophysical and electronic equipment was used. Gamma-ray spectrometric data were processed to correct for variations in atmospheric and flight conditions and statistically evaluated to remove the effect of surface geologic variations. Data were then compared to regional geomorphic lineaments derived from ERTS-1 imagery. Aeromagnetic data were collected simultaneously with the airborne gamma-ray survey and interpreted in terms of regional structure. Ten major anomalous uranium areas and ten less strong anomalous areas were defined within the region surveyed. These anomalies and the known mining districts and uranium occurrences demonstrated good correlation with the ERTS lineaments. The basins were defined by the aeromagnetic data. It is suggested that gamma-ray spectrometer data be supplemented by both the ERTS and aeromagnetic data to best define the targets of greatest potential for further exploration. (auth)

3457 (RMO-447) REPORT ON MOAB DISTRICT, GREEN RIVER DESERT AREA, UTAH. Wardwell, H. R. (Union Mines Development Corp., Grand Junction, Colo. (USA)). Mar 1946. 69p. GJO.

Results are reported from a 1946 geological survey of the Moab District, Green River Desert Area in Grand and San Juan Counties, Utah. The primary purpose of the survey was to determine the amount and grade of U_3O_8 within the area, which was known to have widely scattered vanadium deposits. The uranium ore reserves were calculated on the basis of available field data and chemical analysis of samples of vanadium ores from various locations. It was concluded that the tonnage of high grade ore available did not warrant the deep drilling required for further exploration. (CH)

3458 (RMO-461) GRANITE WASH DISTRICT, HENRY MOUNTAINS AREA, UTAH. Coleman, A. H.; Bryner, L.; Hill, J. W. (Union Mines Development Corp., Grand Junction, Colo. (USA)). Jun 1945. 24p. GJO.

Declassified 8 Dec 1949.

Results are reported from a 1945 geological and topographic survey of the Granite Wash District along the east flank of the Henry Mountains in Wayne and Garfield Counties, Utah. Geologic and topographic maps of the area are included and data are reported on the physiography, stratigraphy, and occurrence of uranium-vanadium ores in the region. It was concluded that uranium mineralization was limited in size and widely dispersed and that the area was only amenable to small scale operations such as exploration by individual miners during periods of high uranium prices. (CH)

3459 (RMO-463) REPORT ON SLICK ROCK DISTRICT, DOLORES PLATEAU AREA, COLORADO. Kirkpatrick, R. K. (Union Mines Development Corp., Grand Junction, Colo. (USA)). Feb 1945. Contract W-7405-eng-78. 62p. GJO.

Results are reported from a 1945 geological and topographic survey of the Slick Rock District of the Dolores Plateau Area, and area 10 by 11 miles in size located in southwestern Colorado 18 miles north of the town of Dove Creek. Topographic and geologic maps were prepared, with emphasis on the distribution of the Morrison formation. Details available of the location and extent of all the uranium-vanadium occurrences in the area are presented and one estimate is included of the uranium ore reserves. It was concluded that underground exploration for uranium ores should be carried out. (CH)

3460 (RMO-468) TEMPLE MOUNTAIN DISTRICT, SAN RAFAEL SWELL AREA, UTAH. Murphy, F. M. (Union Mines Development Corp., Grand Junction, Colo. (USA)). Sep 1944. Contract W-7405-eng-78. 33p. GJO.

The mineralization of the Temple Mountain District, San Rafael Swell area, Utah, was studied during 1944 in relation to uranium and vanadium ore occurrence. This district exhibited many indications of a very large reserve of U_3O_8 and the structure and altitude of the mineralized terrain in relation to topography was such as to favor cheap mining costs of both ore and mineralized materials. (CH)

3461 (RMO-470) MONTICELLO (DRY VALLEY) DISTRICT, GREEN RIVER DESERT AREA, UTAH, COLORADO. Kirkpatrick, R. K. (Union Mines Development Corp., Grand Junction, Colo. (USA)). 21 Aug 1944. Contract W-7405-eng-78. 21p. GJO.

Declassified 1 Nov 1957.

Results are reported from a 1944 survey of the mineralization of the Monticello (Dry Valley) District, Green River Desert area of Utah and Colorado, with emphasis on the occurrence of uranium and vanadium deposits in this area where vanadium had previously been mined. Geologic maps were prepared and samples collected at the location of the old vanadium mines were analyzed for U_3O_8. Results of the survey showed the area to be almost completely depleted of commercial grade vanadium ores, which had an extremely small content of U_3O_8. (CH)

3462 (RMO-476) REPORT ON THE CALAMITY MESA–UNCOMPAHGRE UPLIFT AREA. Kirkpatrick, R. K. (Union Mines Development Corp., Grand Junction, Colo. (USA)). 9 Feb 1944. Contract W-7405-eng-78. 13p. GJO.

Declassified 1 Nov 1957.

Results are reported from a 1944 geological survey of the Calamity Mesa District of the Uncompahgre Uplift Area, Colorado, to determine if any areas of Morrison formation in the vicinity of Gateway might merit exploration for uranium deposits. It was concluded that the presence of uranium ore in this area was unlikely. (CH)

3463 (TM-D-1-12) GEOLOGIC STUDIES AND RECONNAISSANCE FOR URANIUM IN SOUTHEASTERN MONTANA. Curry, D. L. (USAEC Grand Junction Office, Colo. Production Evaluation Div.). Jun 1959. 33p. GJO.

The region discussed in this report occupies an area of about 20,000 square miles in the southeastern part of Montana. Lignite- and coal-bearing strata of late Cretaceous and Paleocene age immediately underlie more than two-thrids of the region, and rocks of Precambrian to Recent age crop out elsewhere in the region. Small deposits of uranium have been found in carbonaceous rocks in the Tongue River member of the Fort Union formation of Paleocene age on the east flank of a small syncline in the Ollie-Carlyle district of Fallon and Wibaux Counties. Small ore-grade occurrences have also been found in carbonaceous rocks in the Hell Creek formation of late Cretaceous age on the west flank of a larger syncline in the Long Pine Hills of Carter County. The uranium in the region was probably derived from leaching of the once-extensive uraniferous White River and Arikaree formations of Oligocene and Miocene age. Transportation of the uraniferous solutions may have been by lateral ground-water migration through partially confined or artesian aquifers. Nearly all known uranium occurrences are in strata possessing at least minor amounts of carbonaceous material, which has a strong affinity for uranium. Deposition of uranium may have been favorably influenced by reductions in the rate of ground-water flow due to decrease in dip. The most promising part of the region for the discovery of uranium ore appears to be the eastern one-third, where most known occurrences exist, and the Big Horn Mountains in the extreme west. Commercial-grade uranium deposits have been discovered in the Madison limestone of Mississippian age of Big Pryor Mountain, a few miles west of the Big Horn Mountains. (auth)

3464 (TM-D-1-13) GEOLOGIC STUDIES WITH RESULTS OF AIRBORNE RECONNAISSANCE IN THE SHAWNEE–LANCE CREEK AREA, CONVERSE AND NIOBRARA COUNTIES, WYOMING. Guillinger, R. R.; Siapno, W. D. (USAEC Division of Raw Materials, Denver, Colo. Denver Exploration Branch). Mar 1956. 23p. GJO.

Fault zones displacing rocks of Oligocene and Miocene Age in the Shawnee district, Converse County, Wyoming were found to contain commercial uranium occurrences. These fault zones, which extend from four miles west of Shawnee northeastward for about 20 miles, appear to have the most favorable potential for uranium deposits. Uranium occurrences were also discovered in channel sandstones rocks of Oligocene and Miocene age and in sandstone lenses of the Fort Union Formation of Paleocene age. Some uranium was found associated with a clastic dike and high anomalous radioactivity was noted in several chalcedony veins in the rocks of Oligocene and Miocene age. An airborne radiometric survey was conducted in the Shawnee-Lance Creek area, Converse, Niobrara and Platte Counties, Wyoming, from June 16 to September 2, 1955. The Fort Union Formation and rocks of Oligocene and Miocene age were given the maximum airborne coverage. Four anomalies were posted by the Atomic Energy Commission following this survey although others were found on privately owned land. (auth)

3465 NMR SPECTRA OF ^{57}Fe IN THE PERIORE BIOTITE AS A PROSPECTING CRITERION FOR RADIOACTIVE ELEMENTS. Ivanits'kii, V. P.; Matyash, I. V.; Rakovich, F. I. (Inst. of Geochemistry and Mineral Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 3, 206-209(Mar 1975). (In Ukrainian).

It is established that NMR spectra of ^{57}Fe in biotites associated with uranic minerals and subjected to prolonged radioactive irradiation contain a quadrupole doublet of the ions Fe^{3+} with the parameters differing from those of doublets of ions Fe^{3+} of ordinary or thermally oxidized biotites. This fact is suggested to be used as a criterion in search for radioactive elements. (auth)

3466 REINTERPRETATION OF GUNNAR GEOLOGY PROVIDES NEW CLUES FOR URANIUM SEARCH. Sassano, G. P. (Concordia Univ., Loyola, Can.). Can. Mining J.; 96: No. 3, 47; 49-51; 53; 55; 57(Mar 1975).

At present some 85% of Canadian uranium production comes from Ontario where, at Elliot Lake, two major companies, Denison Mines Ltd and Rio Algom Mines Ltd, control most of the low-grade quartz-pebble conglomerates occurring above the pre-Huronian unconformity of the Quirke Lake Synform. The remaining 15% is mostly located in northern Saskatchewan, near Beaverlodge Lake. Since the future needs for energy should create a new exploration surge for uranium, it is necessary to reconsider the potential of some uraniferous districts. Specifically this paper aims to re-examine the geology and structure of the Gunnar open pit environs, located on the Crackingstone Peninsula (Beaverlodge area, NW Saskatchewan) on the basis of an extensive literature search and personal examination of the property. (auth)

3467 THE SUPPLY OF NATURAL URANIUM. Report on the DatF-KTG symposium at Mayence on November 18–19, 1974. Braatz, U. (Vereinigung Deutscher Elektrizitaetswerke e.V. (VDEW), Frankfurt am Main (F. R. Germany)). Atomwirt., Atomtech.; 20: No. 2, 87-88(Feb 1975). (In German).

A summarizing report on the symposium is given which primarily delt with the change of the uranium market, the new raw materials policy of the producing countries, new forms of cooperation and the long-term prospects of the natural uranium supply. (GE)

3468 URANIUM MINERALIZATION IN THE PERMIAN OF THE CHOC UNIT OF THE VIKARTOVSKY CHRBAT AREA. Rojkovic, I. (Geologicheskii Institut Slovatskoi Akademii Nauk, Bratislava (Czechoslovakia)). Geol. Zb. Geol. Carpathica.; 25: No. 1, 65-76(Jun 1974). (In Russian).

Uranium mineralization in the Upper Permian of the Choč unit of the Vikartovský chrbát area was studied. Lenses of arcosis sandstones with detritus of carbonized plants were found ore-bearing. The following main ore minerals were determined: pitchblende, pyrite, chalcopyrite, tennantite, galena, and sphalerite. The mineralization is syngenetic. The concentration of the ore minerals was caused by the reduction action of organic detritus. (auth)

3469 ISOTOPE GEOCHRONOLOGY IN THE HIGH-GRADE METAMORPHIC PRECAMBRIAN OF SOUTHWESTERN NORWAY. Versteeve, A. J. Utrecht; Rijksuniversiteit Utrecht (1974). 93p.

Thesis.

Isotope geochronological methods were applied to a high-grade metamorphic terrain in southwestern Norway, in order to arrive at a geochronological framework for the Precambrian evolution of this area. A great number of rocks was investigated including Rb-Sr whole-rock measurements, Rb-Sr and/or K-Ar analyses of separated minerals and U-Pb determinations on Zircon fractions from one sample of charnockitic rock. Also, a Rb-Sr whole-rock isochron analysis was made of the youngest phase of the plutonic complex. Most ages determined lie between 850 and 1200 Ma. (NL)

3470 THE OKLO NATURAL REACTOR: AGE AND EVOLUTION STUDIES BY U–Pb AND Rb–Sr SYSTEMATICS. Lancelot, J. R.; Vitrac, A.; Allegre, C. J. (Paris-6 Univ., 75 (France). Inst. de Physique du Globe). Earth Planet. Sci. Lett.; 25: No. 2, 189-196(Mar 1975).

Some ^{238}U–^{235}U ratios of the Oklo uranium ore are abnormal and confirm the recent discovery of a natural reactor by the French C. E. A. in Gabon. The relationships of these ratios with the U contents show secondary remobilizations. The U-Pb dating of the less perturbed samples gives a primary age of 1.78 b.y. for the ore formation. Examination of all the data points in a U-Pb concordia diagram shows a complex secondary history. The experimental data can be explained by a mixture of components with variable U (or Pb) isotopic composition. (auth)

Radioactive Effluents

Refer also to abstracts 5351 and 5612.

3471 (BNWL-SA-5079) MIGRATION OF RADIONUCLIDE CHAINS THROUGH AN ADSORBING MEDIUM. Lester, D. H.; Jansen, G.; Burkholder, H. C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1974. Contract AT(45-1)-1830. 44p. (CONF-750329-2). Dep. NTIS $5.25.

From American Institute of Chemical Engineers meeting; Houston, Texas, USA (16 Mar 1975).

The migration of actinides and other radionuclides from an underground geologic nuclear waste disposal site through a soil column to a surface water body was investigated for impulse and band releases. Numerical calculation of the analytical solutions revealed that differences in adsorption characteristics between chain members, axial dispersion, and radioactive decay all act to reduce radionuclide discharge rates at the exit of the soil column. The results of the study may have important implications in the underground storage and disposal of nuclear waste. (auth)

3472 (BNWL-tr-139) PLANNED AND UNPLANNED RELEASES OF RADIOACTIVE FISSION PRODUCTS DURING REPROCESSING, FISSION-PRODUCT TREATMENT AND STORAGE: AN ATTEMPTED RISK ANALYSIS. Laser, M.; Bruecher, H.; Merz, E.; Wolf, J. Mar 1975. Translated from German. (CONF-740941-1). 22p. Dep. NTIS $4.25.

From annual convention of the Radiation-Protection Association; Helgoland, F. R. Germany (23 Sep 1974).

Reprocessing plants for spent fuel elements today emit 100% of the ^{3}H and ^{85}Kr contained in the fuel elements and quantities of ^{129}I, ^{131}I, and other aerosols that cannot be ignored. The radiation risk resulting from these routine emissions outweighs the radiation risk caused by possible accidents. The total risk can be reduced considerably by introducing appropriate methods to retain ^{3}H and ^{85}Kr and by improving the iodine retention. The expenditure required for these improvements is compared to the damage that occurs otherwise. The ultimate storage of highly radioactive wastes presents a certain danger to the environment over periods of millions of years. A storage method judged safe by human standards must therefore be selected. By means of an example it is shown that the danger arising from a flooding of an ultimate storage area is very low. (auth)

3473 (UCRL-51781) PLUME DEPLETION FOLLOWING POSTULATED PLUTONIUM DIOXIDE RELEASES FROM MIXED-OXIDE FUEL–FABRICATION PLANTS. Gudiksen, P. H.; Peterson, K. R.; Lange, R.; Knox, J. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Mar 1975. Contract W-7405-Eng-48. 21p. Dep. NTIS $4.00.

An accidental atmospheric release of PuO_2 particles from a nuclear facility may result in deposition of a major fraction of the particles within a few kilometers downwind. Estimates of plume depletion as a function of distance were computed using our atmospheric-diffusion particle-in-cell (ADPIC) code. This code is capable of computing the atmospheric transport, diffusion, gravitational settling, and dry deposition of the PuO_2 particles within a three-dimensional grid under conditions of boundary layer, stratified shear flow. The calculations show the effect on plume depletion due to varying the source height, the particle size, and type of vegetation. Pasquill F stability was chosen for applicability to nuclear facility safety analyses. The fraction of activity remaining in the plume at a given distance increases with source height and is inversely affected by surface roughness. For submicrometer particles emitted at a height of 10 m, the fraction remaining airborne at 30 km downwind is about 0.5 over agricultural land covered with low growing, densely planted leafy vegetables, and only 0.2 over brushland. Because of their large gravitational settling velocities, essentially all particles greater than 5 mu m emitted at a 10 m height are deposited within 5 km of the facility. As the source height is increased, the effect of varying the type of vegetation becomes minimal. Hence, for a 100-m source height, the fraction of submicrometer-size particles remaining airborne is roughly 0.9 at 30 km over agricultural as well as brushland and about 0.25 of the 5-mu m particles are still airborne at 30 km. (auth)

3474 CONCENTRATIONS OF THE MEDICALLY USEFUL RADIONUCLIDES, TECHNETIUM-99m AND IODINE-131 AT A LARGE METROPOLITAN WASTE WATER TREATMENT PLANT. Sodd, V. J.; Velten, R. J.; Saenger, E. L. (Cincinnati General Hospital). Health Phys.; 28: No. 4, 355-359(Apr 1975).

A study was conducted in a Hamilton County sewage system, which services 10 hospitals in the Cincinnati, Ohio, area involved in the practice of nuclear medicine. Samples were intermittently collected for nine days at the sewage treatment plant and from the Ohio River above and below the point of release. The results showed that on a given working day, Monday through Friday, as much as 70 mCi of ^{99m}Tc and 24 mCi of ^{131}I flow through the sewage treatment plant and are released into the river. The dilution of the activity by the Ohio River results in the down-

stream concentration of approx 1 pCi/l ^{99m}Tc and approx 0.3 pCi/l ^{131}I, which are well below their maximum permissible concentrations in water of 6 μCi/l and 0.3 nCi/l, respectively. (auth)

3475 HEALTH AND SAFETY ASPECTS OF CONVENTIONAL AND NUCLEAR GENERATION. Rijks, H. J. (Interuniversitair Reactor Instituut, Delft (Netherlands)). Ingenieur (The Hague); 87: No. 10, 201-203(6 Mar 1975). (In Dutch).

The health and safety hazards of coal-, oil- and nuclear-fuelled power stations are reviewed and compared, as they affect, (a) workers in the industry, and (b) the public at large. Under both headings, nuclear stations appear significantly safer in the light of currently available data. It is emphasized, however, that future extrapolations should take cognizance of the problem of long-term radioactive waste disposal, to which no final solution is yet apparent. (NL)

Radioactivity Monitoring and Transport

Refer also to abstracts 3527 and 3555.

3476 (ARH-SA-226) AERIAL GAMMA SURVEY BY HELICOPTER TO MEASURE SURFICIAL CONTAMINATION. Bruns, L. E. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Mar 1975. Contract AT(45-1)-2130. 20p. Dep. NTIS $4.00.

A program was carried out to determine whether aerial gamma surveys could adequately measure the activity of high specific activity gamma emitters contaminating large land surface areas. The survey successfully measured the ^{137}Cs activity and the total gross gamma over areas from less than 1 to 20 km^2. Also, ^{241}Am was successfully measured over areas wherein the ^{137}Cs was sufficiently low. Micro-curies per m^2 were measured as low as 0.1 for ^{137}Cs and ^{241}Am. Other radionuclides such as ^{60}Co were also detected. An aerial neutron survey was tried, though its efficiency limited detection to areas having more than 10 kg Pu per 4,000 m^2. It was concluded that the aerial survey can analyze a complete area, thereby saving millions of dollars in statistical sampling and analytical programs. (auth)

3477 (BARC/I-278) HEALTH PHYSICS EXPERIENCE IN THE THORIUM PLANT OF INDIAN RARE EARTHS LTD. Dhandayutham, R.; Gohel, C. O.; Nambiar, P. P. V. J. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 12p. INIS.

The report presents the radiation monitoring data for years 1969 to 1972 in the Thorium Plant of the Indian Rare Earths Ltd. The monthwise maximum and minimum dose rates due to radiation in different sections of the Plant and annual personnel exposure dose patterns are given. Measures introduced to control radiation exposure are described. (INIS)

3478 (BNL-19977) 1974 ENVIRONMENTAL MONITORING REPORT. Hull, A. P.; Ash, J. A. (comps.). (Brookhaven National Lab., Upton, N. Y. (USA)). Apr 1975. 82p. Dep. NTIS $7.25.

The environmental levels of radioactivity and other environmental pollutants found in the vicinity of Brookhaven National Laboratory during 1974 are summarized. As an aid in the interpretation of the data, the amounts of radioactivity and other pollutants released in airborne and liquid effluents from Laboratory facilities to the environment are also indicated. The environmental data include external radiation levels; radioactive air particulates; tritium and ^{131}I concentrations; the amounts and concentrations of radioactivity in precipitation; the amounts and concentrations of radioactivity in and the quality of the stream into which liquid effluents are released; the concentrations of radioactivity in sediments and biota from the stream; the concentrations of radioactivity in and the quality of ground waters underlying the Laboratory; and concentrations of radioactivity in milk, grass, and soil samples obtained in the vicinity of the Laboratory. The external radiation level for 1974 at the north boundary of the Laboratory attributable to an ecology forest gamma irradiation source was 6.3 mrem, or 1.3 percent of the applicable radiation protection standard. At the boundary of the Laboratory, about 1.0 km northwest of the Alternating Gradient Synchrotron (AGS), the calculated dose due to skyshine (reflected radiation) was about 1.1 mrem/yr, or 0.2 percent of the standard. This is too small to be measurable. Due to their limited range, the external radiations from the AGS and those from the gamma forest source do not produce a measurable additive effect (less than 0.1 mrem/yr). Other than tritium, there was no indication of BNL radioactive effluents in environmental air and precipitation samples. The largest concentration of tritium in air at the site boundary, 3.5 pCi/m^3 (3.5 x 10^{-11} mu Ci/ml) was 0.01 percent of the radiation concentration guide (RCG). The largest average concentration of tritium in precipitation, 365 pCi/l (3.65 x 10^{-7} mu Ci/ml) was 0.1 percent of the RCG for drinking water. At the Central Steam Plant, one measurement of the stack emission of air particulates indicated that the rate was 0.6 lb/10^6 BTU. This was 600 percent of the emission standard. However, a calculation based on meteorological parameters indicates that at the site boundary, the concentration of air particulates was 0.4 mu g/m^3, or 0.5 percent of the yearly average ambient air quality standard. The calculated concentrations of SO_2 and NO/sub x/ emitted from the plant were both 0.002 ppm, which were 0.7 percent and 0.4 percent of their respective ambient air quality standards. About two-thirds of the liquid effluent released onto the sand filter beds of the BNL sewage treatment plant flowed directly into the Peconic River. Most of the balance is assumed to have percolated into the ground water underlying the beds. The gross beta concentration of the bed output was 97.3 pCi/l (9.73 x 10^{-8} mu Ci/ml), or 3.1 percent of the RCG. However, 61 percent was ^{24}Na, with a half-life of 15 hours. This is so short with regard to the approximately 0.5 ft/day velocity of ground water, that it may be discounted, in which case the effective concentration was only 1.2 percent of the RCG. The tritium concentration was 10.75 nCi/l (1.075 x 10^{-5} mu Ci/ml) or 0.4 percent of the RCG. (auth)

3479 (BNWL-1910) ENVIRONMENTAL SURVEILLANCE AT HANFORD FOR CY-1974. Fix, J. J. (Comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1975. Contract AT(45-1)-1830. 65p. Dep. NTIS $5.45.

During 1974, the work at Hanford included N Reactor operation, nuclear fuel fabrication, liquid waste solidification, continued construction of the Fast Flux Test Facility, continued construction of Washington Public Power Supply System (WPPSS) No. 2 power reactor, Arid Lands Ecology studies, as well as continued use of a variety of research and laboratory facilities. Privately owned facilities located within the Hanford site boundaries include the WPPSS generating station adjacent to N Reactor, WPPSS power reactor site and office buildings, and a radioactive waste burial site. The Exxon fuel fabrication facility is located immediately adjacent to the southern boundary of the Hanford Reservation. Environmental data collected during 1974 showed continued compliance of Hanford operations with all applicable state and federal regulations. Levels of radioactivity in the atmosphere from Hanford operations at all offsite sampling locations were indistinguishable from levels due to natural causes and fallout from nuclear detonations in the atmosphere. Air quality measurements of NO_2 in the Hanford environs recorded a maximum yearly average concentration of 0.006 ppM or 12 percent of the ambient air standard. There was no indication that Hanford operations contributed significantly to these levels. All SO_2 results were less than the detection limit of 0.005 ppM or 25 percent of the ambient air quality standard. Routine radiological, chemical, biological, and physical analyses of Columbia River water upstream and downstream of the Hanford Reservation did not show any identifiable effect due to Hanford operations with the possible exception of water temperature. Levels of radioactivity were similar at both locations and were due to natural and fallout radioactivity. The data indicate an increase of coliform organisms, enterococci, and BOD for the downstream location. These increases are believed to be the result of drainage from farm activities and wildlife. The Hanford stretch of the river serves as a refuge for large populations of waterfowl. Nitrates, pH, turbidity and dissolved oxygen measurements were similar at both locations. The temperature of the Columbia River between the upstream measurement station and the downstream station increases as a result of solar insulation and operations at Hanford. This part of the Columbia River is the last remaining stretch of free flowing Columbia River water in the United States and the amount of solar insulation can raise or lower the temperature of the river water significantly. The maximum temperature of the river water exceeded 20^{0}C (68^{0}F) during a few days during the latter part of August and the early part of September. The annual average temperature and 95 percent confidence interval for Priest Rapids Dam and Richland during 1974 were 11.2 +- 10.9^{0}C and 11.3 +- 11.3^{0}C, respectively, based on 365 daily measurements. Estimates are included of the radiation dose to the human population within an 80-kilometer (50-mile) radius of the site during 1974. Methods used in calculations of the annual dose and 50-year dose commitment from radioactive effluents are discussed. (CH)

3480 (BNWL-1910(Add.)) ENVIRONMENTAL SURVEILLANCE AT HANFORD FOR CY-1974 DATA. Fix, J. J.; Blumer, P. J. (Comps.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1975. Contract AT(45-1)-1830. 106p. Dep. NTIS $5.45.

Data collected by the Hanford Environmental Surveillance program during 1974 are presented in tables. Data are included on

radiological parameters measured in the atmosphere, Columbia River water, drinking water; radionuclides in soil and vegetation, fish and wildlife, and selected foodstuffs; measurements of external radiation doses; and nonradiological parameters measured in the atmosphere, drinking water, and Columbia River water. Methods of sample collection are described briefly. (CH)

3481 (CNEA-PR-1/126) ENVIRONMENTAL MONITORING IN THE VICINITY OF THE ATUCHA NUCLEAR POWER STATION. Beninson, D.; Migliori de Beninson, A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1974. 8p. (In Spanish). INIS.

An environmental monitoring program has been developed for the vicinity of the Atucha Nuclear Power Station, having as main objective the verification of compliance of ICRP recommendations. Using selected models defining exposure pathways and information on the relative composition of the discharged materials, derived working limits have been calculated for several compartments of the model. Sampling locations and criteria for assessing the results of measurements are also presented. (auth)

3482 (LFEN-158-b) ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS AT THE LABORATORIO DE FISICA E ENGENHARIA NUCLEARES (1966–1970). Teixeira, M. M. G. R.; Teixeira, M. R.; Costa, M. M. B. P.; Brito, M. C. F. Q. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). 1973. 7p. INIS.

At the Laboratório de Física e Engenharia Nucleares gross beta activity measurements and radionuclides determinations such as ^{137}Cs, ^{90}Sr, and ^{131}I were carried out in several environmental samples, from 1966 to 1970. Some of these samples were measured for gamma spectrometry. The results obtained are presented and the evolution of gross beta activity since 1961 to 1970 is shown. (INIS)

3483 (MHSMP-75-8) ENVIRONMENTAL MONITORING REPORT FOR PANTEX PLANT COVERING 1974. Alexander, R. E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1 May 1975. 47p. Dep. NTIS $5.50.

During 1974 Pantex Plant conducted a monitoring program to determine the concentration of specific radioactive and nonradioactive species in the local environment. Although the plant activities involved the handling of significant quantities of uranium, plutonium, and tritium, only small releases of uranium (depleted in the isotope ^{235}U) and tritium have occurred which could affect the local environment. Monitoring data indicate that concentrations of these nuclides in the environment are below established criteria for air and water and therefore do not present a health hazard either to employees or to the public. (auth)

3484 (NRL-F-53) ENVIRONMENTAL RADIOACTIVITY. Fallout from Nuclear Weapons Tests Conducted by France in the South Pacific from June–September, 1974. (National Radiation Lab., Christchurch (New Zealand)). Nov 1974. 33p. Dep. NTIS (US Sales Only) $4.75.

The results of the 1974 radiation monitoring program covering France's eighth series of South Pacific nuclear tests are presented. Fresh fission products in air filter and rainwater collections, and iodine-131 in milk, were detected at all collecting stations throughout New Zealand and the central South Pacific area. Westerly excursions of fission products, travelling directly from Mururoa to the central Pacific, were detected from several of the nuclear tests leading at times to marked transient increases in levels of radioactivity. At each station the average levels of contamination, however, were small fractions of the reference levels. In addition the γ radiation dose arising from fallout deposition was a very small fraction of the natural background exposure. Thus it was concluded that the levels reported do not constitute a public health hazard. (auth)

3485 (RFP-ENV-74) ANNUAL ENVIRONMENTAL MONITORING REPORT, ROCKY FLATS PLANT, JANUARY–DECEMBER 1974. (Dow Chemical Co., Denver, Colo. (USA). Rocky Flats Div.). 30 Apr 1975. Contract AT(29-1)-1106. 37p. Dep. NTIS $5.00.

Results of the environmental monitoring program in the Rocky Flats vicinity indicate that the average environmental concentrations of plutonium in air and water during 1974 were less than 1.72 percent of applicable U. S. Energy Research and Development Administration Radioactivity Concentration Guides. Average concentrations of americium-241 and hydrogen-3 (tritium) in water samples were less than 1.0 percent of applicable USERDA Radioactivity Concentration Guides. The release of Be to the environment was also measured. (CH)

3486 (TID-26774) ENVIRONMENTAL MONITORING REPORT, 1974. (General Electric Co., St. Petersburg, Fla. (USA). Pinellas Peninsula Plant). 20 Apr 1975. 24p. Dep. NTIS $4.25.

Results are reported of the effluent and environmental monitoring programs at the Pinellas Plant during 1974. Sample analyses revealed the on-site sewage treatment facility operated well within State of Florida Standards. Likewise, offsite discharges met the applicable standards for arsenic, biochemical oxygen demand, chlorides, chromium, copper, cyanides, detergents, dissolved oxygen, dissolved solids, fluorides, lead, mercury, nitrogen, oils and greases, phenols, pH, phosphorous, suspended solids, turbidity and zinc. The results of iron and specific conductance analyses showed levels in excess of state standards and are discussed in the body of the report. In addition to the non-radioactive parameters listed above, a small quantity of radioactive tritium oxide was released in the plant's liquid effluent. Small quantities of tritium gas, tritium oxide, and krypton-85 gas were released from the plant during the year. Average ground level concentrations of these radioisotopes were all significantly less than 1 percent of recommended guide for continuous nonoccupational exposure. (auth)

3487 (TID-26781) CONCENTRATIONS OF PLUTONIUM ISOTOPES IN AIR AND RAIN SAMPLES COLLECTED AT FAYETTEVILLE, ARKANSAS. Gavini, M. B.; Kuroda, P. K. (Arkansas Univ., Fayetteville (USA). Dept. of Chemistry). [nd]. 5p. Dep. NTIS $4.00.

^{238}Pu and $^{239,240}Pu$ concentrations were measured in a series of air samples collected at Fayetteville, Arkansas during the period from September 3, 1971 to April 13, 1973. The values of the ^{238}Pu activity were found to vary from a low of 1.0×10^{-18} Ci/m^3 (November 26, 1973) to 15.5×10^{-18} Ci/m^3 of air (April 4, 1972), while the $^{238}Pu/^{239,240}Pu$ ratio varied between 0.04 (March 30) to 0.24 (March 16 and March 21, 1972). The wide variation in the ^{238}Pu activity appears to be related to the spring peak of fallout. Plutonium and strontium-90 data were collected in rain samples collected at Fayetteville, Arkansas during the period March 3, 1973 to November 24, 1973. The $^{238}Pu/^{239,240}Pu$ ratio is seen to be very similar to those observed in the air samples during the spring months of 1972. Also included in the data are the $^{239,240}Pu/^{90}Sr$ ratios measured in the rain samples. With the exception of two data points collected on June 29 and Sept. 29, the $^{239,240}Pu/^{90}Sr$ ratio is relatively constant, confirming the constancy of transuranium production and atmospheric behavior relative to the fission product ^{90}Sr. The deviation in the two deviant points may be due to experimental error. (auth)

3488 RAPID MEASUREMENT OF RADON, DECAY PRODUCTS, UNATTACHED FRACTIONS, AND WORKING LEVEL VALUES OF MINE ATMOSPHERES. Hill, A. Health Phys.; 28: No. 4, 472-474(Apr 1975).

A method of determination of the airborne concentration of radon and its short-lived daughters (^{218}Po, ^{214}Pb, and ^{214}Bi), the unattached fraction of the daughters, and the working level value of the airborne concentrations, using a new manipulation of the summation rules results, is proposed. The gross α acitvity and the decay ratio of the gross α activity, properly interpreted, reveal the total α MeV of the sample (working level), the proportional amounts of the radon daughters (individual concentrations), and the RaA growth time (radon concentration). Comparison of two air samples, one open faced and the other preceded by a plate-out chamber, reveal the unattached/attached fraction of the individual daughters. Total information on the airborne concentrations of radon and its short-lived daughters can be determined in this way in a total of 7.5 min and can be obtained at the sampling location. (UK)

3489 TRITIUM CONTAMINATION FROM FALLOUT. Brown, R. C. (Washington State Univ., Pullman). Health Phys.; 28: No. 4, 469-470(Apr 1975).

Following the discovery of tritium surface contamination in and around the Nuclear Radiation Center at Pullman, Washington during the period 9 to 12 July 1973, a full scale investigation of the cause was launched. Significant factors which could have bearing on the source of the contamination, including the fact that contamination was not confined to areas near to the facility and that a nuclear device had been exploded in China on 26 June 1973, are discussed. The contamination data, which shows the absence of typical fallout products, are listed. From these facts a mechanism is proposed to account for the tritium fallout originating from the nuclear explosion in China. An estimation of tritium fallout of 50 Ci/km^2 in the Pullman area is made which, although not a long term hazard, is certainly cause for concern. (UK)

3490 UPPER LIMIT ON ABUNDANCE OF ^{146}Sm IN NATURAL MIXTURE OF SAMARIUM ISOTOPES. Okamoto, H.; Miyajima, M.; Doke, T. (Waseda Univ., Tokyo). J. Inorg. Nucl. Chem.; 37: No. 2, 584-586(Feb 1975).

An attempt was made to measure the abundance of ^{146}Sm in natural samarium using a large cylindrical gridded ionization chamber of very low background, which has been developed re-

cently. No distinct peak of ^{146}Sm was observed in this experiment. The results are discussed and proposals made for further work. (UK)

3491 GUIDELINES FOR MEASURES OF ENVIRONMENTAL MONITORING OF NUCLEAR POWER PLANTS WITH LIGHT-WATER-COOLED REACTORS. Umwelt (Inform. Bundesmin. Inn.); No. 35, 8-14(Oct 1974). (In German).

With tabs.

The guide-lines contain: (1) Task of environmental monotoring and type of control measurements; (a) presentation of evidence prior to the commissioning; (b) release of radioactive materials in normal operation; (c) increased release of radioactive materials due to accidents; (2) measuring programs for the environmental monitoring; (a) presentation of evidence prior to commissioning, setting up of the routine measuring program and testing of the monitoring for air, ground and plant growth, food chains on land and in water, surface water and ground water; (b) routine measuring program such as (a); and (c) accident measuring program, measurement of the air's γ radiation, of the activities with fiber filters, the β-activity, of radioiodine with active carbon filters, of the ground air, of deposit ground and plant tests; and (3) program for measures for the monitoring by official experts. (GE)

Atmosphere

3492 VARIATION OF THE RATIO OF CESIUM-137 TO STRONTIUM-90 IN THE ATMOSPHERE. Sherrill, R. D.; Sumerlin, N. G.; Beck, J. N.; Kuroda, P. K. (Arkansas Univ., Fayetteville). Health Phys.; 28: No. 4, 335-340(Apr 1975).

Concentrations of ^{137}Cs and ^{90}Sr were measured in a total of 137 individual rain and snow samples collected at Fayetteville, Arkansas, during the period between February 1967 and June 1969. The $^{137}Cs/^{90}Sr$ ratio was found to vary quite considerably: 0.26 (12 April 1968) to 8.2 (8 August 1968). Bi-monthly average $^{137}Cs/^{90}Sr$ ratios in rain fluctuated also from 0.75 (January-February 1968) to 1.9 (July-August 1968). The variation in the $^{137}Cs/^{90}Sr$ ratio seems to be attributable to the difference in the size distributions of particulate matters in rain. The ^{137}Cs and ^{90}Sr are depleted in large fallout particles, because of the fairly long half-lives of their precursors: ^{137}Xe (3.82 min) and ^{90}Kr (32.3 sec). A simple calculation, in which the half-lives of the gaseous precursors and the independent and cumulative yields of the fission products belonging to the mass 90 and 137 chains are taken into consideration, shows that extreme values of the $^{137}Cs/^{90}Sr$ ratio in large and small fallout particles expected to be observed in rain may range from about 0.2 to several times the production ratio. (auth)

Soil

Refer also to abstracts 2988 and 4154.

3493 SOIL MONITORING FOR PLUTONIUM AT THE SAVANNAH RIVER PLANT. McLendon, H. R. (Du Pont de Nemours (E. I.) and Co., Aiken, SC). Health Phys.; 28: No. 4, 347-354(Apr 1975).

Since the amount of plutonium in undisturbed soils reflects the cumulative deposition from all sources, both onplant and offplant soils have been collected and analyzed for ^{238}Pu and ^{239}Pu. Results show a background deposition level of approximately 2.0 mCi/km^2 offsite and over most of the plant. This level is well within the range of deposition noted in the southeastern United States and indicates that offsite deposits due to SRP operations are small compared to background. Only samples taken within a 2-km radius of each of the two chemical separation areas show higher levels of plutonium. This elevation indicates some plant contribution. To obtain the above information, new techniques in sample collection and preparation were developed which were comparable with other laboratories in the country. An analytical procedure, involving an anion exchange resin column, was also developed to determine the two plutonium isotopes of interest and to insure increased sensitivity when working with the low level environmental samples. (auth)

Water

3494 (BNWL-1860) RADIOLOGICAL STATUS OF THE GROUNDWATER BENEATH THE HANFORD RESERVATION, JANUARY-DECEMBER 1973. Kipp, K. L. Jr. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1975. Contract AT(45-1)-1830. 31p. Dep. NTIS $4.00.

An evaluation of gross beta and tritium concentrations measured near the surface of the unconfined groundwater at the Hanford reservation during 1973 showed that zones of detectable contamination extended in an easterly to south-easterly direction from 200-E Area as had been observed in the past. Data are included on all measurable tritium, nitrate ion concentrations, and ^{106}Ru concentrations in groundwater samples. (CH)

3495 (ORNL-TM-4751) SYSTEMS ANALYSIS MODEL FOR CALCULATING RADIONUCLIDE TRANSPORT BETWEEN RECEIVING WATERS AND BOTTOM SEDIMENTS. Booth, R. S. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 37p. Dep. NTIS $5.00.

Equilibrium radionuclide concentrations in waters receiving radioactive effluents and in bottom sediments associated with the receiving waters were calculated so that potential doses to man and biota and radionuclide buildup in the environment could be determined realistically. These calculations were performed to test the accuracy of simpler models, where receiving water concentrations were determined by neglecting the influence of bottom sediments. The simplified calculations were incorporated into environmental impact statements for nuclear power stations prepared by Oak Ridge National Laboratory for the U. S. Nuclear Regulatory Commission. A four-compartment systems analysis model was developed to predict dynamic radionuclide transfer. The dependent variables of the model are the receiving water, interstitial water intermingled with the bottom sediments, bottom sediment particles that undergo sorption-desorption reactions with the interstitial water, and bottom sediment particles that undergo only sorption reactions with the interstitial water. The model was used to generate two tables. The first table gives equilibrium radionuclide concentrations in the receiving water when radionuclide transfers to bottom sediments are possible, divided by the receiving water concentrations when transfers to bottom sediments are ignored. These factors are always less than unity, since radioactivity must be conserved, and adding sediments to the system adds another compartment where radionuclide concentrations will equilibrate. The other table lists ratios of equilibrium radionuclide concentrations in sediments, divided by their corresponding receiving water concentrations. These concentrations in the sediments can be used to calculate external doses to a person sunbathing or fishing. Preliminary results indicate that the usual effect of a neglect of sediment interactions is an overestimate of the total potential dose to man from the radionuclides. The reason is that a neglect of sediment interactions overestimates receiving water concentrations which, in turn, overestimates potential doses from important pathways (drinking water or eating fish) directly related to the receiving water concentration. This would not be the case, however, for a situation where exposure to radionuclides in sediments is the critical pathway. The results for ^{137}Cs are particularly interesting since it often causes a major fraction of the calculated dose for a typical release. For environmental parameters appropriate to freshwater lakes in the northeastern states, neglecting sediment interactions could result in potential doses approximately 4 times too high from ^{137}Cs contained in potable water and edible fish. Further, increasing only the K/sub d/ value of a sample of sediment from 27,000 to 270,000 (which reflects measured variations between various freshwater environments) increases this factor from approximately 4 to approximately 25. (auth)

Ecosystems and Food Cycles

Refer also to abstract 3706.

3496 (CONF-750503-5) LABORATORY EXPERIMENTS ON THE TRANSFER DYNAMICS OF PLUTONIUM FROM MARINE SEDIMENTS TO SEA WATER AND TO MARINE ORGANISMS. Mo, T.; Lowman, F. G. (Puerto Rico Nuclear Center, Mayaguez). 1975. 35p. Dep. NTIS $4.75.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

The leachability of $^{239,240}Pu$ from a fine contaminated calcareous sediment to aerated open sea water and to anoxic sea water was measured. The distribution coefficient for $^{239,240}Pu$ from sediment to sea water was 6.1×10^{-5} for aerated water and 2.6×10^{-6} for anoxic water. Experiments on the uptake of $^{239,240}Pu$ by the clams Donax denticulatus, and Lucina pectinata, were done in aquaria containing kilogram quantities of sediment from the Bravo Crater at Bikini Atoll. The concentration factor for $^{239,240}Pu$ by the soft parts of these clams was about 200. All the plutonium taken up in the soft parts was associated with the gill, mantle and siphon. No plutonium was detected in the adductor muscles or hepatopancreas. The smooth surfaces of the shells of the Donax did not show any detectable plutonium, but the rough shell surfaces of the Lucina concentrated plutonium by a factor of 1.10×10^4 over that in the sea water. Marine periphyton cultured on glass plates in an aquarium concentrated $^{239,240}Pu$ by a factor of about 7×10^3 over that in the sea water. (auth)

3497 (CONF-750503-8) RADIOCOBALT CYCLING IN A SMALL MAMMAL FOOD WEB. Willard, W. K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 14p. Dep. NTIS $4.00.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Cobalt-60 seeping from a nearby radioactive liquid waste trench on the Oak Ridge reservation into a temperate deciduous forest ecosystem provided a source of environmental contamination where its dispersion through a small mammal food web could be studied. Maximum radiocobalt concentrations in the soil were found in the upper 5 cm of 15 cm cores. Transient mammals such as the opossum and the raccoon had small amounts of ^{60}Co in their tissues (0.5 and 1.0 pCi/gm, respectively), while the permanent mammal residents including the short-tailed shrew, (80 pCi/g) white-footed mouse (50 pCi/g), golden mouse (50 pCi/g) and the eastern chipmunk (20 pCi/g) had from 27 to more than 100 times that of the transient mammals. The persistent occurrence of ^{60}Co in the small mammals tissues indicated its importance in the food web. Of the potential mammalian food items present in the area, only earthworms (Lumbricus rubellus) contained high levels of ^{60}Co activity (greater than nCi/gm dry wt.). Earthworms collected from the seepage channel eliminated 70 percent of their body burden (gut contents) of ^{60}Co during the first 24-hour period, but retained the remaining 30 percent (tissue accumulation) for more than 11 weeks. Tissue retention by earthworms and the utilization of numerous burrows by mammals along the seepage channel during the summer months suggested that earthworms constituted a major link in the small mammal food chain. (auth)

3498 (EPA-660/3-75-012) MODELING DYNAMICS OF BIOLOGICAL AND CHEMICAL COMPONENTS OF AQUATIC ECOSYSTEMS. Lassiter, R. R. (Southeast Environmental Research Lab., Athens, Ga. (USA)). May 1975. 55p. NTIS.

To provide capability to model aquatic ecosystems or their subsystems as needed for particular research goals, a modeling strategy was developed. Submodels of several processes common to aquatic ecosystems were developed or adapted from previously existing ones. Included are submodels for photosynthesis as a function of light and depth, biological growth rates as a function of temperature, dynamic chemical equilibrium, feeding and growth, and various types of losses to biological populations. These submodels may be used as modules in the construction of models of subsystems or ecosystems. A preliminary model for the nitrogen cycle subsystem was developed using the modeling strategy and applicable submodels. (auth)

3499 RADIOLEAD (^{210}Pb) AND STABLE LEAD IN THE LICHEN CLADONIA ALPESTRIS. Persson, B. R. R.; Holm, E.; Liden, K. (Univ. of Lund, Sweden). Oikos.; 25: No. 2, 140-147 (1974).

Lichens of the genus Cladonia, mainly C. alpestris, collected during 1882 to 1972, were analyzed for stable lead and ^{210}Pb. The specific activity of ^{210}Pb (^{210}Pb/Pb-ratio) indicates a constant value of about 2 $mCi \cdot kg^{-1}$ up to 1940, and then decreased to 0.6 $mCi \cdot kg^{-1}$ during 1950 to 1960. As the average annual ^{210}Pb deposition is relatively constant, the decrease in the ^{210}Pb/Pb-ratio after 1940 indicates an increased deposition of stable lead after 1940. A single exponential variation of the ^{210}Pb/Pb-ratio in respect to latitude, was found in lichens collected in 1964. Values for ^{210}Pb and stable lead in C. alpestris, collected in central Sweden during 1961 to 1972, appear to be relatively constant and the average area-content of ^{210}Pb and stable lead in lichen-carpets was 15 ± 2 $nCi \cdot m^{-2}$ and 25 ± 5 $mg \cdot m^{-2}$, respectively. The pattern of vertical distribution was converted to a model for the translocation of lead in lichens, which included the diffusion-principle. The diffusion coefficient for lead in the top layer of the lichen-carpet was estimated to be about $(0.2 \pm 0.1) \cdot 10^{-6}$ $cm^2 \cdot s^{-1}$. (auth)

3500 CHANGES IN ^{137}Cs CONCENTRATION IN FISH FLESH DURING PREPARATION FOR HUMAN CONSUMPTION. Eyman, L. D. (Oak Ridge National Lab., TN). Health Phys.; 28: No. 4, 476-477(Apr 1975).

To evaluate the effect of preparation on the concentration of ^{137}Cs in fish flesh, samples from largemouth bass (Micropterus salmoides) were prepared by pan frying, pressure cooking, and baking. The decreases in activity were significant ($P \leq 0.05$) for samples that were pressure cooked (8.6%) and baked (8.4%) while a significant decrease was not demonstrated for the pan fried samples (4.9%). (UK)

3501 RADIOCESIUM IN BIRDS OF THE SAVANNAH RIVER PLANT. Straney, D. O.; Beaman, B.; Brisbin, I. L.; Smith, M. H. (Savannah River Ecology Lab., Aiken, SC). Health Phys.; 28: No. 4, 341-345(Apr 1975).

Radiocesium body burdens were determined for 255 birds which were collected in the summers of 1971 and 1972 at six locations on the AEC Savannah River Plant near Aiken, South Carolina. The results suggest that juvenile and adult birds have different patterns of radiocesium uptake which would render them not directly comparable. Juvenile birds showed no significant differences in radiocesium body burden due to locations or diets. Significant levels of radiocesium were found in adult avian communities inhabiting areas near a reactor waste effluent stream and adjacent to a radioactive waste burial ground. Levels of radiocesium in communities from areas more peripheral to the effluent stream and a reactor cooling reservoir, as well as from two control areas were not statistically distinguishable from background. Differences were also apparent due to the diets of birds at each location. Despite the mobility of birds, major environmental discontinuities seem to act as effective barriers to the lateral movement of radionuclides in such avian communities. (auth)

Radiometric Techniques

Refer also to abstracts 3607–3612, 3635–3637, and 4166.

3502 (DESY-L-Ueb-190) ON THE PROBLEM OF NEUTRINO PASSAGE THROUGH THE EARTH. Volkova, L. V.; Zatsepin, G. T. Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1060-1063(1974). 6p. (In German). INIS.

The calculation shows that in principal it is possible to use a neutrino flux from π- and K-meson decay from accelerators to penetrate the earth's sphere in order to obtain information on the density distribution in the earth, if the total effective cross-section of the neutrino interaction with nucleons linearly increases with increasing neutrino energy up to very high neutrino energies. For the assumed experiment, a high-energy proton beam from an accelerator would be necessary and the possibility of generating a well-defined π- and K-meson beam which is directed into the earth. (GE)

3503 (INIS-mf-1679) STATUS REPORT ON NUCLEAR TECHNIQUES IN HYDROLOGY FOR THE END OF INTERNATIONAL HYDROLOGY DECADE (1964–1974). (Indian Agricultural Research Inst., New Delhi. Nuclear Research Lab.). 1974. 22p. INIS.

The report consists of the introductory remarks on the topics, e.g., chronological hydrology, nuclear techniques to determine water in unsaturated and saturated zones, direction and velocity measurements in groundwater by means of radionuclide techniques, and application of isotopic techniques to glaciology and snow hydrology. The Indian contribution on each of the above four subjects is incorporated giving the information on the tracers used and techniques adopted with the major findings of experiments conducted during 1964 to 1974. (auth)

3504 (JUL-1131-ST) TRACER EXPERIMENTS ON THE DISPERSION OF PLUMES OVER TERRAIN OF MAJOR SURFACE ROUGHNESS. Vogt, K. J.; Geiss, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Zentralabteilung Strahlenschutz). Oct 1974. 36p. (CONF-741219-4). Dep. NTIS (US Sales Only) $5.00.

From 1st Asian regional congress on radiation protection; Bombay, India (15 Dec 1974).

Field experiments on the atmospheric dispersion of plumes by turbulent diffusion were carried out in order to measure the diffusion parameters required for environmental exposure calculations. For that purpose, test aerosols, labeled with ^{64}Cu, were released under different weather conditions from the 50 m and 100 m platforms of a meteorological tower, and the ground level concentration distribution below the plume was measured up to a source distance of 10 km with a grid of 100 sampling stations. The results of more than 40 experiments show that, compared with the predictions based on Pasquill's system, the source distance of the ground level concentration maximum is reduced by a factor of 2 to 5, depending on the diffusion category. This discrepancy can be explained by differences in the surface roughness, which is not taken into account in the determination of the diffusion category by systems based on synoptic meteorological observations. A neglection of the increased mechanical turbulence over rough terrain results in an underestimation of the environmental exposure for small source distances and an overestimation for larger distances. In order to enable the application of the results of diffusion experiments to various sites, it is necessary to determine the diffusion categories on the basis of meteorological parameters directly correlated with the local turbulence and, hence, with the surface roughness of the terrain. The measured diffusion parameters were used to calculate the short-time diffusion factors for the various exposure pathways. The long-time diffusion factors, representing the annual concentration distributions in the different sectors of the windrose, were com-

puted by superposition of the short-time concentrations according to the 3-dimensional frequency distribution of wind direction, wind velocity, and diffusion category. (auth)

3505 DENDROCHRONOLOGY AND ^{13}C CONTENT IN ATMOSPHERIC CO_2; AND REPLY. Freyer, H. D. (Kernforschungsanlage Juelich GmbH, Ger.); Wiesberg, L.; Farmer, J. G.; Baxter, M. S. Nature (London); 252: No. 5485, 757(20 Dec 1974).

Comments are offered on Farmer and Baxter (Nature 247:273 (1974)) who published $\delta^{13}C$ values from the wood of tree rings, indicating a decrease over the past 70 years, attributed to the CO_2 increase of the twentieth century. Their results were as expected, but it is stated that some of their implications appear to be questionable. A reply by Farmer and Baxter is appended. (UK)

3506 FISSION TRACK AGES OF VERMICULITES. Nagpal, M. K.; Nagpaul, K. K. (Kurukshetra Univ., India). Sci. Cult. (Calcutta); 40: No. 9, 405-407(Sep 1974).

The suitability of the fossil fission track method for determining the age of vermiculite minerals was studied. The uranium concentration in vermiculite is of the same order of magnitude as in biotite and is higher than the uranium concentration in muscovites. Hence the high uranium concentration and high thermal track stability of vermiculites promise more potentialities for fission track geochronology than the muscovites which have very low uranium concentration and the biotites and the apatites which have low thermal track stabilities. (ERB)

3507 PHYSICAL METHODS IN ARCHAEOLOGY. Tite, M. S. (Essex Univ., Colchester, Eng.). Phys. Bull. (London); 26: 112-114(Mar 1975).

The methods of radiocarbon and thermoluminescent dating of archaeological material are discussed. The basic assumption on which radiocarbon dating depends is that the ratio of $^{14}C/^{12}C$ in the atmosphere has remained constant throughout the period under consideration. However it has now been shown that appreciable variations have occurred as a result of which radiocarbon dates are not strictly absolute. Sources of error in the thermoluminescence method are discussed from which it seems probable that the accuracy will be limited to between ±5 and ±10%. The use of this method to detect fakes is mentioned. (UK)

3508 GROUNDWATER INVESTIGATION IN THE IRAQI WESTERN DESERT (AL-MAT AREA) USING NUCLEAR TECHNIQUE. Al-Badri, A. (Iraq Atomic Energy Commission, Baghdad). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 207-211(Apr 1975).

Four bore holes were drilled in the Iraqi Western Desert (Al-Mat Area) and many isotope injection experiments carried out for the determination of the effective porosity, permeability, transmissibility, storage coefficient and velocity of the underground water flow, using ^{131}I as a radioactive tracer. The result indicated that the aquifer in this area is of good effective porosity, permeability, transmissibility, and storage coefficient and sufficient water is available suitable for economic utilization. The radioactive technique used in drawdown for permeability, transmissibility, and storage coefficient measurement is specific and gave good results while the classical method might be subjected to technical operation error. (auth)

3509 THERMOLUMINESCENT DATING: ASSESSMENT OF ALPHA PARTICLE CONTRIBUTION. Aitken, M. J.; Bowman, S. G. E. (Oxford Univ.). Archaeometry; 17: No. 1, 132-138(Feb 1973).

A new system for specifying alpha source strength, in terms of track length per unit volume of sample, is proposed. It is based on the experimental observation that the TL induced per unit length of track is essentially independent of alpha particle energy. The new system avoids the need to make assumptions about sample stopping power and it is shown to be consonant with the old system as long as up-to-date evaluation of alpha ranges is used. A revised table of dose-rate data is given. (auth)

3510 ABSOLUTE DATING WITH CARBON-14. Mook, W. G. (Rijksuniversiteit Groningen (Netherlands). Natuurkundig Lab.). Ned. Tijdschr. Natuurk.; 41: No. 2, 17-22(25 Jan 1975). (In Dutch).

The principles of radiocarbon dating are summarized, and its role in establishing an absolute chronology in archaeological and geological studies is assessed. It is emphasized that the accuracy of this technique cannot exceed the accuracy of the knowledge about the formation, distribution and decay of ^{14}C. Thus a recent redetermination of the half-life for the decay $^{14}C \rightarrow {}^{14}N + \beta^-$ has resulted in significant corrections (up to +5%) in previously accepted datings. Smaller (but non-negligible) corrections may also be occasioned by atmospheric nuclear tests and cosmic-ray fluctuations. (NL)

3511 ON THE PERFORMANCE OF RADIOMETRIC METHODS USING ^{40}K BETA- AND GAMMA-RADIATION FOR QUANTITATIVE DETERMINATION OF THE K_2O-CONTENT IN THE BEDROCK OF POTASSIUM DEPOSITS. Winter, U. Z. Angew. Geol.; 20: No. 3, 99-102(1974). (In German).

Geophysical conditions of utilizing beta and gamma radiation for quantitative determination of K_2O and boundaries of deposits are given. Practical results of measurement are presented in order to compare performance of the beta and gamma method. (INIS)

3512 RARE-GAS DATING. I. A Demountable Metal System with Low Blanks. Costa, V.; Ferreira, M. P.; Macedo, R.; Reynolds, J. H. (Coimbra Univ. (Portugal)). Earth Planet. Sci. Lett.; 25: No. 2, 131-141(Mar 1975).

The construction and method of operation of an all-metal system for K-Ar and U-He dating is described in detail. The system is capable of handling samples in batches of about 15 g total weight. Blanks are typically 6×10^{-9} cm^3 STP for $^{40}Ar_{atmos}$, $<1.2 \times 10^{-9}$ cm^3 STP for ^4He, and $\sim 2 \times 10^{-9}$ STP for $^{40}Ar_{radiogenic}$. The last of these quantities is independent of the quantity of $^{40}Ar_{radiogenic}$ processed in the preceding run because vapor transport of the sample out of the hottest region of the crucible is very substantial and release of the rare gases in the sample is therefore almost complete. The system is very stable manometrically; monitoring of spike peaks therefore permits detection of any gas loss which amounts to more than a few percent. The system is not very suitable for analysis of large samples. (auth)

3513 LEAD ISOTOPES AND AGE OF HAWAIIAN LHERZOLITE NODULES. Morioka, M.; Kigoshi, K. (Gakushuin Univ., Tokyo (Japan). Faculty of Science). Earth Planet. Sci. Lett.; 25: No. 2, 116-120(Mar 1975).

Observed lead isotopic compositions and contents of uranium, thorium, and lead of lherzolite nodules in Hawaiian basalts support a view that the nodules are refractory residue of primary upper mantle materials. The isochron by lead isotopes gives an age of 3.5 b.y. suggesting the time of separation of parent body of lherzolite nodules (pyrolite?) from more primeval material. (auth)

3514 RARE-GAS DATING. II. Attempted Uranium-Helium Dating of Young Volcanic Rocks from the Madeira Archipelago. Ferreira, M. P.; Macedo, R.; Costa, V.; Reynolds, J. H. (Coimbra Univ. (Portugal)); Riley, J. E. Jr.; Rowe, M. W. (Texas Agricultural and Mechanical Univ., College Station (USA). Dept. of Chemistry). Earth Planet. Sci. Lett.; 25: No. 2, 142-150 (Mar 1975).

Uranium-helium ages have been determined for a suite of 25 whole-rock basalts from Madeira and Porto Santo islands in the Madeira Archipelago. Petrographic descriptions of these samples are included. Uranium measurements were by delayed-neutron activation analysis. Helium measurements were by isotopic dilution in the all-metal system characterized by very low argon and helium blanks. For 19 of the samples preferred K-Ar ages were also obtained. None of the rocks are concordant in these two ages; all have lost helium. The uranium-helium ages are best described, on the average, as equal to 74% of the K-Ar ages minus 0.2 m.y. Nevertheless in the suite of young, chemically similar lavas the correlation between the K-Ar age and the helium content is good enough to make the helium measurement worthwhile as a check on a possibly anomalous argon age, especially in a system where the additional labor required to make the helium is minimal. The Columbia River basalt from which standard samples BCR-1 and BCS-2 were prepared was also dated. Its uranium-thorium-helium age, 4.45 ± 0.24 m.y. shows that this rock has retained even less of its radiogenic helium (30%) than the island basalts. (auth)

Site Surveys

Refer also to abstract 4154.

3515 (COM-74-11666) STATE UNIVERSITY OF NEW YORK AND CORNELL UNIVERSITY ANNUAL REPORT, 1972–1973. Report for October 1972–November 1973. (State Univ. of New York, Albany (USA); Cornell Univ., Ithaca, N. Y. (USA)). 1974. 54p. NTIS $4.25.

Sea Grant's second year in New York was marked by three major accomplishments: the multicampus organizational network grew stronger and sharpened the focus of diverse parts of SUNY and Cornell on specific areas; mechanisms for establishing program goals and priorities through the advisory councils were considerably refined; and a long-term strategy for meeting these goals was worked out. Information is given on methods of raising awareness, managing resources, working with industry, and methods of siting power plants. (GRA)

3516 (PB-230276) GUIDE FOR PLANNING AND ZONING OFFICIALS IN CONSIDERING ATOMIC ENERGY FACILITY ZONING ACTION. Proposed American Standard. (American Standards Association, New York (USA). Section Committee). Jun 1965. 23p. NTIS $4.25.

The report is intended to serve as a guide for industry and planning and zoning officials toward the orderly review of the needs of atomic energy facilities for specific parcels of land such that the use of land by atomic energy installations shall be encouraged for the general welfare and not result in an excessive public health and safety problem. (GRA)

3517 (SWECO-7501) TWO-DIMENSIONAL COASTAL STORM SURGE MODEL. (Stone and Webster Engineering Corp., Boston, Mass. (USA)). Jan 1975. vp.

A transient two-dimensional mathematical model was developed to simulate storm surges in a coastal area. Time-dependent meteorological parameters of the wind storm over the coastal area, such as wind stress and atmospheric pressure gradient, are incorporated into the vertically-integrated momentum and continuity equations. Effects of bottom friction, bathymetry of ocean, islands, river inflow and outflow, and earth rotation are also included in the model. Boundary conditions are provided at the open boundaries to approximate the actual conditions during the storm. The governing equat ions are solved numerically by a finite difference method. The model yields transient two-dimensional velocities and surge heights. A computer program was developed which generates the transient pressure gradient and wind shear for the Probable Maximum Hurricane over the grid layout for input to the two-dimensional storm surge program. The program requires characteristics of Probable Maximum Hurricane over the area of interest and the hurricane track. Changes in direction, acceleration and deceleration of the hurricane can be simulated by specifying the track. The September 12, 1938 and September 14, 1944 hurricanes, two of the largest to have landfall in New England, were used to simulate the surges in the Long Island Sound and the adjacent coastal area. Outputs of surge heights at locations with a recording gage station were compared with actual data for verification. The predicted and observed surge hydrographs compare very favorably in magnitude and timing of surges. The combination of these two programs can be used to predict surges in Atlantic and Gulf coastal area for the Probable Maximum Hurricane. Detailed formulation, description, and use of both programs are presented. (auth)

3518 SENSITIVITY OF ATMOSPHERIC DIFFUSION ESTIMATES TO METEOROLOGICAL DATA RECOVERY AND ACCURACY. Woodard, K. (Pickard, Lowe, and Associates, Inc., Washington, DC). Nucl. Technol.; 25: No. 4, 635-639(Apr 1975).

Parametric studies using 26 site-years of meteorological data from 10 different nuclear reactor sites were made to determine the sensitivity of diffusion estimates to selected aspects of meteorological measurement programs. These sensitivities were determined by comparing diffusion estimates obtained using the actual data records with estimates obtained by altering the same record to simulate incomplete data recovery and instrument error. Variations from one year to the next were also explored, as was the effect of varying assumed wind speeds for calm hours. Results indicate that sufficiently accurate estimates, well within the accuracy and conservatism of the diffusion models, can be made with a smaller data base and with less measurement accuracy than required by U. S. Atomic Energy Commission guidelines. (auth)

3519 REGIONAL SITING SURVEY FOR THERMAL POWER PLANTS IN THE STATE OF OHIO. Elkins, M. L.; DiNunno, J. J. (NUS Corp., Rockville, MD). Nucl. Technol.; 25: No. 4, 724-740 (Apr 1975).

The selection and evaluation of sites for power plants have become increasingly difficult in recent years as pressures from various societal segments have resulted in government restraints on selection and burning of fossil fuels, on methods of heat dissipation, on acquisition of transmission line rights-of-way, and on environmental impact in general. The key elements in successful application of power plant siting technology are the development of the proper balance among the basic siting considerations and the understanding that level of detail in a study varies in an inverse relationship with the siting area under examination. As the first step in the process of selection and eventual licensing of new thermal power plant sites for a utility in the State of Ohio, the entire state was screened to determine promising candidate regions large enough to offer several possible candidate sites for thermal power plants. Because of the size of the area under consideration and the advantages of developing sites with an ultimate capacity for more than one power plant, sites with an installed capacity of 1100 to 4400 MW(e) were considered for this study. As a result of the preliminary screening conducted in four distinct steps, three candidate regions showed the best overall promise for either nuclear or fossil-fueled power plant development. Tentative identification was made of candidate sites within these candidate regions, and follow-on studies conducted in an increasing level of detail are presently in progress to determine the candidate site(s) most promising for power plant siting. (auth)

Thermal Effluents

Refer also to abstracts 3475, 3479, 3480, 5796, and 5803.

3520 (COM-74-50356) BIBLIOGRPHY OF THE NEW YORK BIGHT. Part 1. List of Citations. Report on Marine Ecosystems Analysis Program. (National Oceanic and Atmospheric Administration, Rockville, Md. (USA). Environmental Science Information Center). Jan 1974. 194p. GPO.

Includes COM-74-50357.

The New York bight extends from Montauk Point, Long Island, to Cape May, New Jersey, and from the coastline to the edge of the continental shelf. This bibliography includes literature on maritime law, administration, air pollution, meteorology, solid waste management, and navigation. It also includes literature of Long Island Sound and the hydrology and regional geology of the New York-New Jersey Coastal Zone. The bibliography consists of two parts: a list of citations of published information, and a set of indexes (separately bound). Specific subjects covered are: aquatic biology; oceanography; meteorology and climatology; geology; law; administration; sociology; air, water, solid waste and thermal pollution; industries; energy; mineral extraction; transportation; fisheries; and recreation. (GRA)

3521 (COM-74-50357) BIBLIOGRAPHY OF THE NEW YORK BIGHT. Part 2. Indexes. Report on Marine Ecosystems Analysis Program. (National Oceanic and Atmospheric Administration, Rockville, Md. (USA). Environmental Science Information Center). Jan 1974. 495p. (NOAA-74041009-2). GPO.

Includes COM-74-50356.

The New York bight extends from Montauk Point, Long Island, to Cape May, New Jersey, and from the coastline to the edge of the continental shelf. This bibliography includes literature on maritime law, administration, air pollution, meteorology, solid waste management, and navigation. It also includes literature of Long Island Sound and the hydrology and regional geology of the New York-New Jersey Coastal Zone. The bibliography consists of two parts: a set of indexes, and a list of citations of published information (separately bound). Specific subjects covered are: aquatic biology; oceanography; meteorology and climatology; geology; law; administration; sociology; air, water, solid waste and thermal pollution; industries; energy; mineral extraction; transportation; fisheries; and recreation. (GRA)

3522 (DP-MS-75-11) DISTRIBUTION AND ABUNDANCE OF SUBMERGED MACROPHYTES, INCLUDING MYRIOPHYLLUM SPICATUM L. (ANGIOSPERMAE), IN A REACTOR COOLING RESERVOIR. Grace, J. B.; Tilly, L. J. (Clemson Univ., S. C. (USA); Du Pont de Nemours (E.I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). 1974. Contract AT(07-2)-1. 18p. (CONF-750433-1). Dep. NTIS $4.00.

From Savannah river thermal ecology symposium; Aiken, South Carolina, USA (2 Apr 1975).

The distribution of aquatic macrophytes, including Myriophyllum spicatum L., in a reactor cooling reservoir was analyzed by biomass removal. Samples were collected by use of a corer from hot, warm, and cold stations at progressive distances from a thermal effluent. Standing crop was doubled at the warm station as compared to the cold station due to the enhancement of Myriophyllum spicatum L. However, M. spicatum was least abundant at the hot station where Najas guadalupensis (Spreng.) Morong. predominated. Possible causes for the restriction of M. spicatum from the hot station are given. Maximum rooting depth of vegetation was reduced near the effluent apparently due to a combination of decreased light penetration and a higher photosynthesis-respiration compensation level at higher temperatures. (auth)

3523 (PB-224056) EFFECT OF THERMAL INPUTS ON THE POPULATIONS OF FISH AND MACROINVERTEBRATES IN THE WABASH RIVER. Technical Completion Report. Gammon, J. R. (DePauw Univ., Greencastle, Ind. (USA)). Jun 1973. 118p. NTIS $4.25.

The distribution of fish and macroinvertebrate populations near two electrical generating stations located on the Wabash River were examined during the summer and early fall for six years. Segments of the river were subdivided into zones corresponding to the imposed thermal conditions and to different kinds of habitat. Fish responded readily to changing thermal conditions and concentrated in areas of the river which provided temperature close to their optimum. Although most species reacted behaviorally to the altered thermal conditions, only two groups appeared to be

affected permanently as populations. Flathead catfish (Pylodictis olivaris) responded to higher temperatures with enhanced reproductive success which increased population density two or three times. Redhorse (Moxostoma erythrurum and M. breviceps) are more thermally sensitive and population densities are likely to be reduced with higher temperatures. Complicating factors include the fact that several species of fish, including redhorse and sauger (Stizostedion canadense), appear to rely upon recruitment from trieutaries to sustain the mainstem populations. Long-term changes in the density of other species were not detected. (GRA)

3524 ENVIRONMENTAL EFFECTS OF COOLING SYSTEM ALTERNATIVES AT INLAND AND COASTAL SITES. Miner, R. M. (URS Energy Services Co., San Mateo, CA); Warrick, J. W. Nucl. Technol.; 25: No. 4, 640-650(Apr 1975).

The environmental effects of alternative cooling systems for power plants in California were analyzed. At inland sites evaporative cooling systems must be used, with fresh water or waste water used as makeup. Because fresh water is scarce, most new plants would need to use agricultural or municipal waste waters. For agricultural waste water systems, disposing of the blowdown and dispersion of drift containing total dissolved solids are two significant problems requiring resolution. At coastal sites, once-through cooling systems or recirculating systems could be used. Once-through cooling causes fewer effects on the marine environment than do recirculating systems on the air and marine environment when ocean water makeup is used. In general, for a recirculating system, dispersing high-salinity blowdown in marine waters and the effects of salt water drift on the terrestrial ecology outweigh the effects of once-through warm water on marine life. (auth)

Chemical Effluents

Refer also to abstracts 3475, 3479, 3480, 3483, 3486, and 5799.

3525 (CONF-750503-6) DISTRIBUTION OF CHROMIUM IN VEGETATION AND SMALL MAMMALS ADJACENT TO COOLING TOWERS. Taylor, F. G, Jr.; Parr, P. D.; Dahlman, R. C. (Oak Ridge National Lab., Tenn. (USA)). 1975. 22p. Dep. NTIS $4.25.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Surface contamination of vegetation by aerosol pollutants and subsequent ingestion by grazing vertebrates is a pathway for incorporation of toxic elements into food chains. Small mammals (herbivores) were live-trapped in a fescue-dominated field adjacent to large, mechanical draft cooling towers comparable to those utilized by power generation facilities. Cooling waters of the towers contain a chromate, zinc-phosphate compound to inhibit corrosion and fouling within the cooling system. A fraction of the cooling water becomes entrained within the exit air flow and is deposited as drift on the landscape. Resident mammals are chronically subjected to increased chromium exposures through both ingestion and inhalation pathways. Concentrations in vegetation ranged from 342 to 15 ppM at 15 and 130 meters downwind. Concentration levels in litter exceeded those of live plant materials by a factor of 5. Chromium distribution in mammals adjacent to the cooling towers is compared by organ analyses to corresponding organs and tissues of mammals collected remote from drift. Concentrations of chromium in pelt, hair, and bone of animals trapped near the cooling towers were significantly higher (P is less than 0.01) than tissues from control animals. Air concentrations ranged from 15 to 8 mu g/m^3 at 15 and 100 meters, and thus provided a potential pathway for increased chromium levels through inhalation. Biological accumulation and retention following ingestion are discussed in a subsequent paper in this symposium (Van Hook et al.). Elevated levels of hexavalent chromium in air have been identified as a potential health hazard. Pathological studies of lung tissues were performed and were negative for lesions. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 3721, 3822, 3823, 3839, 4188, 4977, 5078, 5092, 5204, and 5420.

3526 (CONF-750303-55) FISSION CROSS SECTION MEASUREMENTS ON SHORT-LIVED ALPHA EMITTERS. Dabbs, J. W. T.; Hill, N. W.; Bemis, C. E.; Raman, S. (Oak Ridge National Lab., Tenn. (USA)). 1973. 2p. Dep. NTIS $4.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

The large difference in initial ionization can be used to limit the size of alpha pulses relative to fission pulses in an ionization chamber, if the track lengths are both short. In parallel plate chambers this condition is not well met. A spherical plate chamber in which the ratio of maximum/minimum track length is 3 is described. In the present (small sample) version, the maximum track is 6 mm, with deposit and neutron beam diameters of 1 cm. At optimum, with pure CH_4 gas, an electron collection time of approximately 22 ns is expected across the 2 mm gap. It is expected that the worst alpha/fission current pulse ratio will not exceed $1/_{14}$. Thus fissile isotopes with alpha half lives of 30 years or more (e.g., ^{243}Cm) may be studied with 1 to 2 nanosecond rise-time current amplifiers; in addition, very small spontaneous fission branching ratios may be better determined. Comparisons of this new chamber with a parallel plate chamber and initial results on ^{248}Cm (approximately 16 mu g sample) are presented. The ORELA pulsed neutron source permits measurements below 20 eV which are inaccessible to underground explosion experiments. (auth)

3527 (COO-3382-14(Vol.2), pp III,1-III,11) DESIGN OF A CONTINUOUS DIGITAL-OUTPUT ENVIRONMENTAL RADON MONITOR. Wrenn, M. E.; Spitz, H.; Cohen, N. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

A new field instrument for the continuous measurement of radon concentrations was developed to investigate the magnitude and variability of environmental levels of ^{222}Rn. Passive diffusion of radon, but not its daughters, occurs through an open pore polyurethane foam into a sensitive volume where a static electric field directs the positively ionized radon daughter products to a central collecting electrode. Pulses in a ZnS (Ag) scintillator, resulting from the alpha emission of ^{218}Po and ^{214}Po, are observed with a photomultiplier tube and counted using standard NIM electronics. The detector unit has been fabricated into a small, convenient package for indoor air sampling without the use of air movers or pumps. The unit is unobtrusive and acceptable into a daily routine without disrupting normal family or business activities. The monitor can detect as little as 0.5 pCi/l for a 40-min. count (alpha equals .05). The equilibrium detection efficiency of the instrument is 0.7 cpm/pCi/l. (auth)

3528 EXPERIMENTAL TEST OF THE CALCULATED EFFICIENCY OF THE HARWELL BLACK DETECTOR AT HIGH NEUTRON ENERGIES USING THE HARWELL LONG COUNTER. Coates, M. S.; Gayther, D. B.; Hunt, G. J.; Boyce, D. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 41-45 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The Harwell black detector has an essentially constant time response in the neutron energy range 10 eV to 700 keV with a fast enough time response to be used in time-of-flight experiments. Recently the theoretical efficiency calculated by Monte-Carlo techniques has been confirmed experimentally. It is considered that the relative efficiency has been established to ±2%. (1 figure, 1 table) (auth)

3529 TWO FLAT-RESPONSE DETECTORS FOR ABSOLUTE AND RELATIVE NEUTRON FLUX MEASUREMENTS. Poenitz, W. P. (Argonne National Lab., IL). pp 47-61 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The application of the Grey Neutron Detector at higher neutron energies is considered. The detection of different capture γ-rays provides for a satisfactory check of the evaluated efficiency functions. A new detector, the Black Neutron Detector, was designed for absolute neutron flux measurements in the MeV energy range. The detector has a fast time response and converts the primary neutron energy into proton recoil energy. The energy sum spectra obtained from these proton recoils allows a simple extrapolation to zero energy and thus an accurate absolute count-rate determination. The detector is a promising instrument for accurate cross-section experiments in the MeV energy range. (9 figures) (auth)

3530 PRECISE NEUTRON FLUX MONITORING BY $T(p,n)^3He$ ASSOCIATED-PARTICLE COUNTING BETWEEN 0.25 MeV AND 1.3 MeV. Leroy, J. L.; Szabo, I.; Tocquer, J. Y. (CEN de Cadarache, France). pp 63-73 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The associated-particle method has been used to monitor neutron flux produced by the $T(p,n)^3He$ reaction in the energy range 0.25 MeV to 1.3 MeV. $^3He^{++}$ particles were counted with a solid-state detector after unwanted charged particles had been eliminated with an analyzer which employed both electric and magnetic fields. Associated-particle counting has been used independently to confirm a previous calibration of a long counter by the $MnSO_4$ bath method within experimental errors of both methods. (1 table, 7 figures) (auth)

3531 ABSOLUTE NEUTRON FLUX DETERMINATION IN THE ENERGY REGION BETWEEN 0.4 MeV AND 2 MeV. Kaeppeler, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 75-83 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

A detector for absolute neutron flux determination in the energy range between 0.4 MeV and 2 MeV is described. It is based on the hydrogen scattering cross section as a standard and works similarly to a proton recoil telescope. The main advantage is that corrections are almost entirely avoided. To establish its reliability, the influence of all parameters which determine the accuracy has been checked carefully. In this way, an overall uncertainty of the determined neutron flux of about ±2% was reached. (3 tables, 4 figures) (auth)

3532 NEUTRON FLUX MEASUREMENTS AT THE LLL LINAC. Czirr, J. B.; Sidhu, G. S. (Univ. of California, Livermore). pp 85-88 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From second IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Three detector systems to cover three overlapping energy ranges will be used in high accuracy measurements of the ^{235}U fission cross section with the LLL linac: (1) Thermal to 100 keV—thin ^6Li glass scintillator; (2) 50 keV to 2 MeV—gas-filled proportional counter; (3) 1 to 20 MeV—proton recoil telescope. The status of each detector system is reported. (5 figures) (auth)

3533 LARGE AREA LIQUID SCINTILLATORS. Katsperski, L. (Univ. Lodz, Poland); Kotel'nikov, K. A.; Petrov, S. V. Acta Phys. Pol.; A47: No. 2, 251-253(Feb 1975). (In Russian).

The basic parameters of liquid scintillator detectors of the area (3.0×0.4) m^2 and their construction are described. The scintillators are constructed on the basis of "white spirit" with PPO and POPOP in amounts 1 g/l and 0.03 g/l, respectively. The received inhomogeneity amounts to (16 ± 1)%; it corresponds to the edge-center effect of about 1.4. (auth)

3534 CHANNELTRON EFFICIENCY FOR COUNTING OF H^+ AND H^- AT LOW ENERGY. Crandall, D.H.; Ray, J.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Cisneros, C. Rev. Sci. Instrum. 46: No. 5, 562-564 (May 1975).

The counting efficiency of a channel electron multiplier is measured for H^+ and H^- impact with the input of the Channeltron grounded and for impact energies between 0.3 and 5 keV. The counting efficiency is found to be about 30% greater for H^- than for H^+ at energies below 1 keV. This difference and an observed difference between H^- and H^+ in the variation of counting efficiency across the Channeltron opening are attributed to the surface potential of the Channeltron near the opening, which can accelerate or decelerate the incident particles. (auth)

3535 EVALUATION OF PHOTOMULTIPLIER TUBES FOR USE IN PHOTON COUNTING CORRELATION SPECTROSCOPY. Gethner, J.S.; Flynn, G.W. (Department of Chemistry, Columbia

University, New York, New York 10027). Rev. Sci. Instrum. 46: No. 5, 586-591 (May 1975).

A simple experimental technique is described for qualitatively determining the afterpulse spectrum of a photomultiplier tube for use in a photon counting mode. Results for several common photon counting tubes are evaluated with particular interest in the use of the tube for photon correlation spectroscopy (PCS) applications. A discussion of the problems which arise due to afterpulsing is included. (auth)

3536 RESPONSE OF THIN FILM PLASTIC SCINTILLATOR TO FISSION FRAGMENTS. Batra, R. K.; Shotter, A. C. (Edinburgh Univ. (UK)). Nucl. Instrum. Methods; 124: No. 1, 101-106 (15 Feb 1975).

Thin plastic scintillator films of different thicknesses are prepared and their characteristic response to fission fragments from ^{252}Cf is studied. It is observed that the peak to valley ratio of fission fragments depends nonlinearly upon the thickness of thin films. This ratio for the heavy fragments is larger than that of the light fragments by a factor of 1.5 to 1.9 for the whole range of thickness investigated. The laminated structure of the films shows slightly higher gain (~5%) but the resolution remains practically the same. The energy loss of fission fragments in plastic scintillator (NE 102A) is measured. A simple system for a "start-detector," employing such a thin film and a photomultiplier, is also described for the time-of-flight experiments. (auth)

3537 SPIRAL CATHODE SPARK CHAMBERS FOR RADIOCHROMATOGRAPHY. Pullan, B. R. (Manchester Univ. (UK)); de Lima, J. J. P. (Coimbra Univ. (Portugal)). Nucl. Instrum. Methods; 124: No. 1, 149-151(15 Feb 1975).

This paper describes and discusses the performance of spark chambers which are designed to visualize the distribution of β-emitting radioactivity on chromatograms. The chambers comprise an assembly of individual detectors with spiral wire cathodes and concentric wire anodes. This design leads to ease of construction with good uniformity of sensitivity and stability of operation; sufficient for routine use in radiochromatography. (auth)

3538 SPURIOUS EVENTS IN SPIRAL CATHODE SPARK CHAMBERS. de Lima, J. J. P. (Coimbra Univ. (Portugal)); Pullan, B. R. (Manchester Univ. (UK)). Nucl. Instrum. Methods; 124: No. 1, 153-155(15 Feb 1975).

The main difficulty in using spark chambers in routine laboratory applications such as autoradiography is the appearance of spurious sparks which are not associated with the passage of ionization radiation through the gas of the detectors. This paper describes an investigation of the production of initiatory electrons from the cathode surfaces of detectors by field emission effects. Electron emission rates from cathode surfaces have been measured as a function of applied electric field, cathode material and spark frequency. The results show that emission rates are high enough to account for a significant proportion of spurious sparks. Other effects leading to ionization in the gas will also contribute to the spurious sparking rate. Conclusions are drawn as to suitable materials for spark counter cathodes. (auth)

3539 AN ANALYTIC EXPRESSION FOR THE GAMMA-RAY SELF ABSORPTION IN THE PERPENDICULAR-AXES CONFIGURATION. Horowitz, Y. S.; Mordechai, S.; Dubi, A. (Ben-Gurion Univ. of the Negev, Beersheba (Israel)). Nucl. Instrum. Methods; 124: No. 1, 313-314(15 Feb 1975).

An analytic expression for the self absorption of gamma rays emitted from a point source on the face of a cylindrical absorber is constructed. The symmetry axis of the cylindrical absorber makes an angle of 90° with the symmetry axis of the cylindrical detector. (auth)

3540 COMPUTER PROCESSING OF SCINTILLATION CAMERA IMAGES. Inouye, T. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center). Nucl. Instrum. Methods; 124: No. 1, 215-219(15 Feb 1975).

A rapid computer method for processing images obtained by scintillation cameras for medical diagnosis is described. The main features of the processing methods are the data smoothing technique by applying nonlinear filtering and image resolution improvement using a non-damping filter function in the frequency domain. (auth)

3541 LONG-TIME BEHAVIOUR OF REGENERATING IN-CORE NEUTRON DETECTORS WITH ^{238}U–^{239}Pu ELECTRODES DURING POWER CYCLING. Boeck, H.; Balcar, E. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Nucl. Instrum. Methods; 124: No. 2, 563-571(1 Mar 1975).

A general expression for the ^{238}U-^{239}Pu fission chamber sensitivity as a function of time is derived for arbitrary consecutive changes of the neutron flux. The maximum error of the detector sensitivity is given in relation to the equilibrium condition. Several different modes of power cycling have been calculated for demonstration. The maximum sensitivity error at the most severe power variation (one single power reduction of –100%) did not exceed 2.3%. (auth)

3542 AUTOMATIC SPARK COUNTING OF FAST-NEUTRON-INDUCED RECOIL-PARTICLE TRACKS IN POLYMER FOILS. Becker, K.; Abd-el Razek, M. (Oak Ridge National Lab., Tenn. (USA)). Nucl. Instrum. Methods; 124: No. 2, 557-561(1 Mar 1975).

It is shown that not only fission-fragment and alpha-particle tracks, but also heavy-recoil-particle tracks which are produced by direct fast-neutron interaction with organic foil (or foil cover) constituents can be counted automatically with the well-known automatic "spark-counting" technique. Extended etching of cellulose-nitrate and polycarbonate foils of 10 μm thickness to a point close to that at which electrical breakdown would occur in unexposed foils resulted in good counting efficiency for the recoil tracks. There is a pronounced increase in sensitivity with increasing neutron energy. (auth)

3543 GERMANIUM α-PARTICLE DETECTORS WITH ALUMINUM REGROWTH p^+ CONTACTS. Lidow, A. (California Inst. of Tech., Pasadena (USA)). Nucl. Instrum. Methods; 124: No. 2, 609-610(1 Mar 1975).

Solid-phase epitaxial regrowth techniques have been used to form thin p^+ contacts on n-type germanium. Aluminum layers 400 to 1000 Å thick were evaporated on germanium, heated to 300 to 350°C and slow-cooled to form p^+ layers. Resolutions of 14 keV for 6.05 MeV α-particles were obtained consistently on 25 mm^2 detectors cooled to liquid-nitrogen temperatures. (auth)

3544 SEPARATION OF ISOBARIC ELEMENTS BY THE ENERGY-LOSS DISPERSION IN CARBON ABSORBER FOILS. Clerc, H. G.; Schmidt, K. H.; Wohlfarth, H.; Lang, W.; Schrader, H.; Pferdekaemper, K. E.; Jungmann, R. (Technische Univ. Darmstadt (F. R. Germany). Inst. fuer Kernphysik); Asghar, M.; Bocquet, J. P.; Siegert, G. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)). Nucl. Instrum. Methods; 124: No. 2, 607-608(1 Mar 1975).

Fission fragments provided by the mass separator "Lohengrin" were slowed down in a homogeneous 1.2 mg/cm^2 thick carbon absorber. By measuring the residual energy with a time-of-flight method, a resolution of $Z/\Delta Z = 45$ at $Z = 40$ was achieved. (auth)

3545 INVESTIGATIONS ON ENERGY RESOLUTION IN DETECTING ALPHA PARTICLES USING A CELLULOSE NITRATE DETECTOR. Lueck, H. B. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Nucl. Instrum. Methods; 124: No. 2, 359-363(1 Mar 1975).

The influence of the etching process and the error of the microscopic measurement on the energy resolution has been investigated. Energy resolution in the range from 3.5 to 6.0 MeV has been found to be about 48 keV. This method of energy determination can be used for alpha particles with energies greater than 2.7 MeV. The energy range which may be evaluated in a single etching process amounts to 800 to 1000 keV. The efficiency covers a span from 7.8% to 14.1% depending on the energy of the particles. (auth)

3546 A GAS IONIZATION COUNTER FOR PARTICLE IDENTIFICATION. Fowler, M. M.; Jared, R. C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nucl. Instrum. Methods; 124: No. 2, 341-347(1 Mar 1975).

A method is described for the identification of products from nuclear reactions. A gas ionization counter is used as a tin (0.8 mg/cm^2) transmission detector in a counter telescope particle-identification system. The response of the system is approximately linear in Z for the ions produced by heavy-ion-induced fission of medium-Z targets. Reaction products with Z up to ~30 can be well resolved. Methods of fabrication of entrance windows for the counter are discussed and a procedure for determination of the window thickness is presented. Generally entrance windows were either Formvar or VYNS with a thickness of 40-60 $\mu g/cm^2$. (auth)

3547 EXPERIMENTAL SET-UP FOR ASYMMETRY MEASUREMENTS IN THE ELASTIC SCATTERING AT SMALL ANGLES (<10°) OF 40 MeV POLARIZED PROTONS. Bendiscioli, G.; Lodi Rizzini, E.; Marciano, C.; Rotondi, A.; Venaglioni, A. (Pavia Univ. (Italy). Istituto di Fisica). Nucl. Instrum. Methods; 124: No. 2, 397-405(1 Mar 1975).

An experimental set-up based on the use of a magnetostrictive readout wire spark chamber is described. It has been used for the measurement of the asymmetry between 0° and 10° in the elastic scattering of 40 MeV polarized protons. It is characterized by a high angular resolution and allows the determination of the distribution of the protors in the incident beam. Details on the use of the magnetostrictive delay lines are given. (auth)

3548 OPTIMUM TRACK-PARAMETER DETERMINATION IN PRESENCE OF SMALL-ANGLE MULTIPLE SCATTERING AND MEASUREMENT ERRORS. Alkhazov, G. D. (AN SSSR, Leningrad. Inst. Yaderno) Fiziki). Nucl. Instrum. Methods; 124: No. 2, 407-412(1 Mar 1975).

The problem of optimum track-parameter determination is considered using the method of linear treatment of the data. Optimum weighting functions ensuring the ultimate precisions under the simultaneous presence of multiple scattering and measurement errors are derived and the ultimate accuracies are found for several cases of interest. (auth)

3549 APPLICATION OF THE FINITE-DIFFERENCE APPROXIMATION TO ELECTROSTATIC PROBLEMS IN GASEOUS PROPORTIONAL COUNTERS. Urbanczyk, K. M. (HYDROKOP State Enterprise, Krakow, Poland); Waligorski, M. P. R. (Institute of Nuclear Physics, Krakow (Poland)). Nucl. Instrum. Methods; 124: No. 2, 413-428(1 Mar 1975).

The basic principles of the finite-difference approximation applied to the solution of electrostatic field distributions in gaseous proportional counters are given with the aim of making this method more popular with authors dealing with electrostatic problems. When this method is used, complicated two-dimensional electrostatic problems may be solved, taking into account any number of anodes, each with its own radius, and any cathode shape. A general formula for introducing the anode radii into the calculations is derived and a method of obtaining extremely accurate (up to 0.1%) solutions developed. Several examples of potential and absolute field distributions for single rectangular and multiwire proportional counters are calculated and compared with exact results according to Tomitani, in order to discuss in detail erros of the finite-difference approximation. (auth)

3550 RESPONSE OF THIN-FILM SCINTILLATOR DETECTORS TO HIGH-ENERGY ARGON AND KRYPTON IONS. Muga, L. (Florida Univ., Gainesville (USA). Dept. of Chemistry). Nucl. Instrum. Methods; 124: No. 2, 541-546(1 Mar 1975).

The luminescence response of a thin-film detector (TFD) to the passage of accelerated argon and krypton ions is recorded for an energy range (up to 7.2 MeV/nucleon) not previously studied. With increasing heavy-ion energy the TFD response increases quickly to a maximum near 3 MeV/nucleon and then slowly decreases. The general trends observed are consistent with those calculated on the basis of a previously reported model of heavy-ion luminescence production. Concurrent energy-loss measurements of argon ions differ somewhat from calculated values. The expected diminished TFD response as specific energy loss increases is confirmed for the higher-energy range of incident ions. Improved resolution of thicker scintillator films indicates the possibility of establishing the identity of medium-heavy ions ($Z = 18$ to $Z = 36$) to within two charge units using a film thickness of ~0.4 mg/cm^2. Comments on the applicability of the TFD to various experimental areas are made. (auth)

3551 A STUDY OF (n,p) AND (n,α) REACTIONS IN NaI(Tl) USING A PULSE-SHAPE-DISCRIMINATION METHOD. Bartle, C. M. (Wisconsin Univ., Madison (USA). Dept. of Physics). Nucl. Instrum. Methods; 124: No. 2, 547-550(1 Mar 1975).

The events due to (n,p), (n,α) and (n,nγ) reactions produced by monoenergetic neutrons incident on a NaI(Tl) scintillator are distinguished using pulse-shape-discrimination. Cross section measurements for the ^{23}Na(n,p)^{23}Ne and ^{23}Na(n,α)^{20}F reactions are presented for neutron energies between 5.5 and 8.5 MeV. (auth)

3552 A POSITION-SENSITIVE IONIZATION CHAMBER. Sann, H.; Damjantschitsch, H.; Hebbard, D.; Junge, J.; Pelte, D.; Povh, B.; Schwalm, D.; Tran Thoai, D. B. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 2, 509-519(1 Mar 1975).

A position-sensitive ionization chamber for the detection of heavy ions is described which measures the energy E, the specific energy loss dE, the arrival time t and the two space coordinates x and y of the detected ion. Resolutions (fwhm) of about $\Delta E = 68$ keV and $\Delta dE = 75$ keV were obtained for 5.49 MeV α-particles ($dE = 1.1$ MeV), and of $\Delta t < 2$ ns and $\Delta x < 0.8$ mm and $\Delta y < 1.1$ mm for fission fragments of a ^{252}Cf source. The active area of the entrance window of the ionization chamber was $(x \times y) = (1.5 \times 5.0)$ cm^2, but areas up to about (10×50) cm^2 are possible. (auth)

3553 GAMMA DETECTION IN LIQUID XENON AND MEASUREMENT OF THE AVERAGE IONIZATION ENERGY. Gadenne, M. C.; Lansiart, A.; Seigneur, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Nucl. Instrum. Methods; 124: No. 2, 521-526(1 Mar 1975). (In French).

A three-electrodes ionization chamber of 5 cm in diameter and 5 cm thick has been built to detect gamma rays in liquid xenon. Average ionization energy $\bar{W}$ measured with the chamber is found to be equal to 16.5 eV. Preliminary gamma-ray spectra are presented and results on the resolution are discussed. (auth)

3554 EFFICIENCY CALIBRATION OF GAMMA- AND X-RAY DETECTORS IN THE ENERGY RANGE BELOW 200 keV. Berenyi, D.; Meszaros, S.; Seif El Nasr, S. A. H.; Bacso, J. (Magyar Tudomanyos Akademia Atommag Kutato Intezete, Debrecen). Nucl. Instrum. Methods; 124: No. 2, 505-508(1 Mar 1975).

The efficiency calibration of a Be-window NAI(Tl) x-ray detector, a Si(Li) x-ray detector and a 20 cm^3 Ge(Li) detector was carried out in the energy range 6 to 198 keV, using standard sources of ^{57}Co, ^{133}Ba, and ^{241}Am, as well as a non-standardized source of ^{182}Ta. The relative intensities of two gamma rays from ^{182}Ta were determined for which no recent data exist, and new absolute intensity values for several low-energy gamma rays from ^{133}Ba are also given. (auth)

3555 SEPARATION OF HT, NOBLE GASES AND HTO VAPOR WITH SEMIPERMEABLE MEMBRANES. Howell, R. H.; Cate, J. C.; Wong, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nucl. Instrum. Methods; 124: No. 2, 579-583(1 Mar 1975).

The maximum permissible concentration for a 40 hr week (MPC) of tritium gas (HT) in air is 2000 nCi/l. The MPC for tritium oxide (HTO) vapor in air is 5 nCi/l. The MPC for HTO is a factor of 400 lower than the MPC for HT. Many air monitoring techniques such as air ionization chambers do not differentiate among the chemical forms of the tritium measured. They respond to the total radioactivity contained in the sample. Due to the large difference in MPCs, monitors and survey meters which have a higher response to HTO than to HT will reflect a more accurate assessment of the exposure. A new technique for measuring the airborne concentration of tritium-oxide vapor in the presence of molecular tritium gas and radioactive noble gases is presented. The radioactive species are separated using semipermeable membranes. (auth)

3556 A METHOD FOR STABILIZING THE EFFICIENCY OF COPPER-WALLED CO_2-FILLED PROPORTIONAL COUNTERS. Alessio, M.; Bella, F.; Improta, S. (Rome Univ. (Italy). Istituto di Fisica). Nucl. Instrum. Methods; 124: No. 2, 597-599(1 Mar 1975).

The maximum age measurable with the ^{14}C method can be increased by lengthening the counting time, if the count fluctuations are kept within the limits of statistical errors. In copper-walled CO_2 filled counters a systematical decrease in counting rate was observed, due to the formation of impurities, which does not allow a suitable lengthening of the counting time. An apparatus is described consisting of a counter through which the filling gas, continuously purified, is made to flow slowly during the measurement. This makes it possible to extend the duration of the measurements with copper-walled CO_2-filled counters. (auth)

3557 RESOLUTION IMPROVEMENT IN CdTe GAMMA DETECTORS USING PULSE-SHAPE DISCRIMINATION. Jones, L. T.; Woollam, P. B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Nucl. Instrum. Methods; 124: No. 2, 591-595(1 Mar 1975).

Pulse-shape discrimination has been used to improve significantly the resolution of CdTe gamma detectors. By selecting those pulses with risetimes less than 100 ns, the full width at half maximum (fwhm) resolution at 661 keV may be reduced to 14 keV at room temperatures and 8 keV at 0°C. The resulting peaks have a full width at tenth maximum(fwtm) less than twice the fwhm and may readily be identified and integrated using standard spectrum-analysis techniques. (auth)

Radiation Dosimeters

3558 (N-74-28561) STUDY OF BLOOD FORMING ORGAN DOSE AS A FUNCTION OF PROTON ENVIRONMENT. Final Technical Report. Khandelwal, G. S. (Old Dominion Univ., Norfolk, Va. (USA). Research Foundation). Jun 1974. Contract NAS1-9434. 7p. (NASA-CR-132475). NTIS $4.00.

It is demonstrated that a dosimeter that consists of four ion chambers, each with different wall thickness, is able to reproduce the BFO dose with reasonable accuracy. This generalized dosimetric system is only slightly more complex than dosimeters in current use. This preliminary development had two built-in assumptions; the isotropicity of the radiation and the neglect of nuclear reaction effects. Only the nuclear reaction effects have been calculated. (auth)

3559 PERSONNEL DOSIMETERS. Skotnikov, V. I.; Laptev, V. V. pp 5-14 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section deals with individual dosimeters. The instruments in this group are used on a large-scale. They differ from each other in mode of construction arrangement and operating parameters. Consideration is given to the basic technical data and structural schemes of individual dosimers of the DK-02 type containing an integrating ionization chamber with an electrometer having a quartz loop, individual dosimeters of the KID-2 type with condenser chambers and completely transistorized, and instruments of the "Kanarelka" and "Solovel" type. These instruments measure gamma dose and, approximate gamma exposure rate, and determine the presence of beta radiation and thermal neutrons. (SJR)

3560 GROUP DOSIMETERS. Portable Apparatus. Skotnikov, V. I.; Laptev, V. V. pp 15-29 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section describes a number of features, and presents a number of characteristics of instruments having an autonomous or circuit feed that are used for dose control at operating sites. The detectors in these instruments are ionization chambers or tissue-equivalent scintillation counters whose current is a measure of the x ray and gamma radiation. In devices measuring neutron dose, use is made of scintallation counters having a phosphor and a corresponding light-registering device. The basic element in these instruments is the measuring control panel. A description is also given of features of dosimeters used in medical centers, laboratories and clinics. (tr-SJR)

3561 STATIONARY DOSIMETERS. Radiation Dose Control at Definite Points in Industry Buildings or in the Surrounding Area. Skotnikov, V. I.; Laptev, V. V. pp 30-38 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section presents basic characteristics, and describes the structural arrangements and principles of operation of instruments used to control dose and dose rate in operating buildings, laboratories and controlled areas. The instruments ordinarily measure the magnitude of the current registered in the ionization chamber output circuit. As a rule the instrument gives a signal on exceeding a certain dose rate, and consists of a control panel and rugged detectors. A number of instruments are equipped with accessory features (automatic recording of radiation level, outputting of information on radiation level from a number of points on a cathode-ray tube screen, etc. (tr-SJR)

3562 CONDITIONS AND RULES FOR DOSIMETER OPERATION. Skotnikov, V. I.; Laptev, V. V. pp 39-45 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section briefly describes the conditions of operation for three groups of dosimetric instruments: individual dosimeters, group control instruments and control instrumentation in buildings. Consideration is given to general problems in selecting measuring equipment used in dosimeter maintenance, and to possible deficiencies of various component elements. A technique is described for determining instrument deficiencies. (tr-SJR)

3563 REPAIR AND CALIBRATION OF PERSONNEL DOSIMETERS. Skotnikov, V. I.; Laptev, V. V. pp 46-58 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section describes the operating principles and schematics of individual dosimeters of the type KID-1, the pocket dosimeter DK-02 and the individual dosimeter-radiometer DUG 2-01. Consideration is given to finding deficiencies both in the instrument as a whole and in its component elements. Possible instrument deficiencies are presented. A technique of calibrating dosimeters is described. (tr-SJR)

3564 GROUP DOSIMETER REPAIR. Skotnikov, V. I.; Laptev, V. V. pp 58-84 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section describes the schematics of instruments used for radiation control at operating sites (the neutron dosimeter DN-A-I, the medical micro-x-ray-meter MRM-2 and the portable x ray meter RP-I). Consideration is given to methods of finding deficiencies in component elements of the instruments, and characteristic deficiencies are presented. A method of calibrating the dosimeters under plant or laboratory conditions is described. (tr-SJR)

3565 STATIONARY DOSIMETER REPAIR. Skotnikov, V. I.; Laptev, V. V. pp 85-100 of Dozimetry. Moscow; Atomizdat (1973). (In Russian).

This section considers problems in the construction and repair of recording units in stationary dosimeters (unit signaling an overexposure from gamma radiation SD-IM, signal-measurement two-channel dosimeter of the type USIT-2, and the multichannel control unit "System"). Characteristic deficiencies are presented, possible reasons for the deficiencies are indicated, and hints are given on eliminating the deficiencies. A technique for calibrating stationary dosimeters is described. (tr-SJR).

3566 DETERMINATION OF THE CALORIC DEFECT FOR THE ABSORPTION OF SOFT X-RAYS. Saebel, M. Erlangen, Ger.; Univ. Erlangen, Nuremberg (1972). 140p. (In German). INIS.

Thesis.

A method is described with which one can determine the caloric defect, i.e., the share of absorbed energy of soft x-rays which is not converted into heat. The twin calorimeter developed for these measurements consists of a calorimeter container and various inserts with which the caloric defect and the necessary correction parameters can be measured. The measuring principle used in the determination of the caloric defect is based on the assumption that with quanta- or electron energies up to a few MeV, in metals having medium and high atomic weights, the total energy absorbed appears as heat. Thus if the same quantity of incident energy is totally absorbed by a metal absorber and by the sample to be examined, then the caloric defect can be determined by the difference of the thermal energy produced by both absorbers. The caloric defect in tissue equivalent materials (reactor graphite, PVC, PMMA, PE, polystyrol) is mostly a few percent of the absorbed energy and takes on considerable values in particular cases (e.g., –25% in PMMA). It is, therefore, absolutely necessary to determine the caloric defect if the tissue equivalent material is used as absorber in an accurate calorimetric measurement of the energy dose. (auth)

3567 AN ISOTHERMAL TWIN CALORIMETER FOR THE DETERMINATION OF THE HEAT EFFECT OF LOW ENERGY X-RAYS. Saebel, M.; Schmidt, T.; Pauly, H. (Erlangen-Nuernberg Univ., Erlangen (F. R. Germany). Inst. fuer Physikalische und Medizinische Strahlenkunde). Radiat. Environ. Biophys.; 11: No. 3, 247-257(Oct 1974).

The paper describes the construction and operation of an isothermal twin calorimeter for the measurement of the fraction of absorbed energy of x-rays which is not converted to thermal energy (heat). This fraction, the "heat defect," must be known in absolute dose calorimetry, since the calorimetrically measured absorbed dose in a given substance is too low by the value of the heat defect for the radiation and the substance used. One of the absorbers of the twin calorimeter was the substance to be investigated. The other was the reference absorber consisting of lead. It was assumed that the heat defect of the radiation used (30 kV and 50 kV X-rays, LET from 1 to 30 keV/μm tissue-equivalent material) in lead was practically zero. Attention was paid to a precise determination of the energy losses by the different kinds of scattered radiation in the different absorber substances. The energy losses by coherent scattered, incoherent scattered and fluorescence photons and by photo, Compton and Auger electrons were experimentally determined. They are in the range from 1.8% to 2.3% with an error of 0.3%. The values for the heat defect in carbon and in the different kinds of plastics used in dosimetric studies were found to be between zero and 7% with an average experimental error of about 0.8%. After knowing the heat defect in the different kinds of absorber substances it is possible to construct an absolute dose calorimeter with a precision given by the accuracy of the value for the heat defect. (auth)

3568 WHAT IS NEW IN THE FIELD OF LUMINESCENCE DOSIMETRY. Report on the 4th International Conference on Luminescence Dosimetry, Krakow, Poland, August 27 to 31, 1974. Oberhofer, M. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). Atomkernenergie; 24: No. 4, A26-A32(1974).

Papers presented at this conference deal with basic mechanisms in luminescence dosimetry, with established and new materials and techniques, with instrumentation problems and applications in personnel and medical dosimetry. (GE)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 4807 and 5011.

3569 (A.R.E.A.E.E.-192) RESPONSE CHARACTERISTICS OF Ge(Li) DETECTOR FOR THERMAL NEUTRON CAPTURE GAMMA-RAY SPECTROSCOPY. Eissa, E. A.; Rofail, N. B.; El-Kady, A. A.; Hassan, A. M.; Abu-Zeid, H. M. (Atomic Energy Establishment, Cairo (Egypt)). 1974. 23p. Dep. NTIS (US Sales Only) $4.25.

An external target facility at one of the horizonal experimental ports of the UA-RR-1 2 MW research reactor has been set-up for thermal neutron radiative capture reactions using a true coaxial Ge(Li) detector of 30 cm^3 intrinsic volume. Gamma-ray spectra from standard radioactive sources as well as thermal neutron radiative capture in ^{35}Cl, ^{54}Fe, ^{56}Fe and ^{1}H were used in finding out the energy-dependence, from 100 to 9300 keV, of the full-energy single-escape and double-escape relative efficiencies

of our Ge(Li) detector. Response characteristics towards gamma-ray full-energy, single-escape and double-escape detection mechanisms were deduced for this detector. The results obtained can help in decomposing complex gamma-ray spectra and evaluating the intensities of the nuclear gamma-ray transitions. (auth)

3570 (CEA-N-1700, pp 142-144) MULTIWIRE PROPORTIONAL CHAMBER USING INTERPOLATION. Bricaud, B.; Chaminade, R.; Cros, M.; Durand, J. M.; Faivre, J. C.; Pain, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A new reading system for multiwire proportional chambers is described. It permits a good rapidity with a very simple electronic data acquisition system. The resolution can be better than 0.5 millimeter with a reading gap of 36 millimeters. (auth)

3571 (CEA-N-1700, pp 147-151) 1 GeV SPECTROMETER ELECTRONICS. Chaminade, R.; Lugol, J. C.; Sillon, Y.; Faivre, J. C.; Legrele, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Some progress in the detection electronics at the 1 GeV spectrometer is described in this section. At the last we report the CAMAC branch highway driver for the 1 GeV experiment computer (C.90 40). (auth)

3572 (CEA-N-1700, pp 151-152) CHERNEKOV COUNTERS FOR PROTONS. Legrand, D. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A system of Cherenkov counters delivering the start signal of drift counters, with a good rejection of deuteron background is described, and some improvements on the experimental results as SPES I, due to these counters, are presented. (auth)

3573 (CEA-N-1700, pp 152-153) NEW DETECTION FOR THE 180° MAGNETIC SPECTROMETER. Boudard, A.; Briatte, J.; Bricaud, B.; Bruge, G.; Chaumeaux, A.; Chianelli, C.; Garin, A.; Gillet, M.; Re, C.; Rouger, M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A new experimental set-up was designed to achieve the best possible energy resolution for 20–30 MeV alpha particles from the 180° magnetic spectrometer. Using new 10 cm silicon dE/dx position sensitive counters, an energy resolution of 18 keV was obtained for 30 MeV alpha particles scattered by a ^{60}Ni target. This resolution is mainly due to the contribution of the target thickness effects. The counters were made in the laboratory. (auth)

3574 (CEA-N-1700, pp 183-185) DEVELOPMENT OF A RANGE PROTON SPECTROMETER FOR STUDYING THE ^{4}He(γ,pπ^-)(ppn) REACTION. Anderson, G.; Argan, P.; Audit, G.; Bloch, A.; Faure, J. L.; Laget, J. M.; Lopata, C.; Martin, J.; Schuhl, C.; Tamas, G. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A range detector used to measure proton energies in 50 to 250 MeV energy range with about 10 MeV energy resolution is described. (auth)

3575 (CEA-N-1700, pp 204-212) DETECTION FOR THE 600 AND 900 MAGNETS OF THE HE1 ROOM. Auriol, E.; Dupont, J.; Lefevre, J.; Lemarchand, G.; Millaud, J.; Mougey, J.; Royer, D. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The multiwire chamber systems implemented in the 900 spectrometer of the HE1 room are described, their specifications are compared with those of the multiwire systems expected to be associated with the 600 spectrometer. The electronics and a new acquisition program for (ee') and (e,e'p) reactions are described. (auth)

3576 (CEA-N-1700, pp 212-214) NEEDLE CHAMBERS. Grunberg, C.; Le Devehat, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Some properties and possibilities of needle chambers which seem to be of high interest in a large field of activities are discussed. (auth)

3577 (CEA-N-1700, pp 249-251) FISSION NEUTRON DETECTOR. Lucas, B.; Trochon, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A large volume proton recoil detector to be used for fission neutron detection is described. (auth)

3578 (CEA-R-4664) REAL TIME SYSTEM OF GAMMA SPECTRUM ACQUISITION AND TREATMENT FOR A TRIDAC C UNIT WITH DISC. Hulot, J. P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Div. de Metallurgie et d'Etude des Combustibles Nucleaires). Apr 1975. 281p. (In French). Dep. NTIS (US Sales Only) $17.25.

Thesis. Submitted to Paris Univ., Orsay.

A program system prepared for the LECI TRIDAC C (Intertechnique) unit is described. This system is used for the γ spectrometric examination of irradiated fuels. Four measurement lines are connected to this apparatus which allows the acquisition of spectra, their processing in real time and the presentation of results in the form of curves. In building this system it was necessary to develop a very elaborate logic, particularly a real time monitor and a disc supervisor for the management of data records. (auth)

3579 (JINR–D3-7991, pp 196-232) EXPERIMENTAL AND THEORETICAL ASPECTS OF HIGH RESOLUTION NEUTRON SPECTROSCOPY. Cierjacks, S. (Kernforschungszentrum, Karlsruhe, Ger.). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The first part of this lecture briefly reviews recent developments in high-resolution neutron spectrometers. Particular attention is given to fast-neutron spectrometers used with isochronous cyclotrons. In the second part, some theoretical aspects are discussed. Major concern is devoted to spin and parity assignments by means of the "a few angle" scattering method. The application of this method for the study of level spacing, level widths, and strength functions and their J and l dependence is demonstrated. The usefulness of the combined interpretation of neutron transmission and scattering experiments for the identification of intermediate structure phenomena in terms of doorway states is outlined in conclusion. (15 figures) (RWR)

3580 (JINR–P10-8453) M-400 SMALL COMPUTER ORIENTED DISPLAY UNIT. Gryaznov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The unit is intended for using in the spectrometry systems for effective man-computer communication. Exchange of information between the small computer and unit realized in the program data transfer mode increases the flexibility of the unit. The presence of some modes of the unit's work allows one to select the mode corresponding to the type of visualized information, to simplify mancomputer communication programming and to reduce servicing time. (auth)

3581 NEUTRON SPECTROSCOPY AND LATTICE DYNAMICS. Dolling, G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 541-629 of Dynamical Properties of Solids. Horton, G. K.; Maradudin, A. A. (eds.). Amsterdam; North-Holland Publishing Co, (1974).

Many properties of solids are describable in terms of the behaviour of certain basic excitations such as phonons, excitons, magnons, etc. In order to understand these properties, it is most desirable to study the appropriate basic excitations in as much detail as possible over a wide range of conditions (of temperature, pressure, etc.). The most powerful techniques for such studies involve the observation of the scattering of radiation from the solid: in general, one attempts to measure the changes in energy and momentum suffered by the radiation as it passes through the solid and interacts in various ways with the basic excitations. The use of beams of thermal neutrons as a radiation probe to study the phonons in a solid is studied. Some brief remarks on the application of X-ray thermal diffuse scattering measurements to the study of lattice vibrations are given. Much of the discussion of this chapter applies equally well to the study of excitations rather than phonons, (magnons, or spin waves in magnetic materials, have also been very widely studied by neutron scattering methods) but these topics are outside the scope of the present book. (auth)

3582 AUTOMATIC CONTROL AND DATA ACQUISITION OF MAGNETIC β-RAY SPECTROMETER MEASUREMENTS. Sattler, E.; Hansen, H. H.; Hofmans, K.; Mouchel, D.; Nerb, H.; Schipke, H. (Commission of the European Communities, Geel (Belgium). Central Bureau for Nuclear Measurements). Nucl. Instrum. Methods; 124: No. 1, 131-142(15 Feb 1975).

The development of a versatile electronic system for control and data acquisition in connection with a goniometer-type magnetic β-ray spectrometer is described. Besides the commercially available transistorized power supply the electronic system consists of a magnet current control unit including an automatic demagnetization routine and a read-out control unit. Use has been made of CAMAC standard equipment as much as possible. Experi-

mental tests are performed on stability and reproducibility of the complete installation. (auth)

3583 CURVED CRYSTAL SPECTROMETER FOR PRECISE ENERGY MEASUREMENTS OF GAMMA RAYS FROM 30 TO 1500 keV. Borchert, G. L.; Sheck, W.; Schult, O. W. B. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Instrum. Methods; 124: No. 1, 107-117 (15 Feb 1975).

A DuMond-type spectrometer with an interferometric angle measuring system is described. It has a focal length of 464 cm, a crystal window of 22 cm^2, and uses the (110) plane of quartz. The interferometer yields an angular accuracy of about 0.01 seconds of arc. Therefore, the spectrometer permits extremely precise measurements of the relative energies of x- or γ-lines. Strong transitions can be recorded with a relative precision of $(1\text{-}5) \times 10^{-6}$, as is shown through the measurement of γ-lines from the decay of ^{196}Au, ^{199}Au, ^{182}Ta, and ^{183}Ta. (auth)

3584 A LARGE EFFICIENCY NEUTRON COUNTER FOR TIME-OF-FLIGHT MEASUREMENTS. Evers, D.; Spindler, E.; Konrad, P.; Rudolph, K.; Assmann, W. (Muenchen Univ. (F. R. Germany). Sektion Physik); Sperr, P. (Technische Univ. Muenchen (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 1, 23-28(15 Feb 1975).

An 8 cm $\phi \times 1$ m liquid scintillator (NE213) neutron counter is presented which gives a subnanosecond time resolution for neutron energies higher than 22 MeV. The scintillator is viewed from both ends by Valvo XP 1041 photomultipliers. The counter performance including n–γ pulse shape discrimination is demonstrated by the results of neutron time-of-flight measurements. (auth)

3585 THE ARGON UNIFORM-FIELD GAS PROPORTIONAL SCINTILLATION COUNTER: IMPROVED ENERGY RESOLUTION FOR α-PARTICLES AND ITS BEHAVIOUR FOR X-RAYS. Conde, C. A. N.; Ferreira, M. F. A. (Coimbra Univ. (Portugal)). Nucl. Instrum. Methods; 124: No. 1, 307-308(15 Feb 1975).

Energy resolutions of 1.6% for 8.1 MeV α-particles were obtained with the argon uniform-field gas proportional scintillation counter. The energy resolutions for 22 keV and 5.898 keV x-rays were 12.2% and 27%, respectively. The usefulness of this counter is discussed. (auth)

3586 GENERAL FORMULAS FOR CALCULATION OF SAVITZKY AND GOLAY'S FILTER WEIGHTS AND SOME FEATURES OF THESE FILTERS. Sterlinski, S. (Institute of Nuclear Research, Warsaw (Poland)). Nucl. Instrum. Methods; 124: No. 1, 285-287(15 Feb 1975).

General formulas are derived on the base of the moment analysis and Lagrange's method for the conditional extreme. By this mathematical approach other filters can be created. One example of such a new filter (box-like) is given. Some features of Savitzky and Golay's filters with regard to noise reduction and the flattening of the smoothing peaks are discussed. (auth)

3587 THE PERFORMANCE OF A LIGHT-PULSER-OPERATED DIGITAL STABILIZER. Porges, K. G. A. (Argonne National Lab., Ill. (USA)). Nucl. Instrum. Methods; 124: No. 1, 235-241(15 Feb 1975).

This note describes the performance of several similar stabilizer systems intended for scintillation counting channels. In neutron time-of-flight spectrometry, the absence of strong and permanent features in the pulse height spectrum necessitates use of a light pulser for stabilization reference purposes. Such a system lends itself to a description in terms of random walk theory, which is used here to derive the response to a step excursion in gain and the natural gain fluctuation as a function of several adjustable parameters. (auth)

3588 THEORY OF DIGITAL FILTERING IN CORRELATION TIME-OF-FLIGHT SPECTROMETRY. Amadori, R.; Hossfeld, F. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). Nucl. Instrum. Methods; 124: No. 2, 429-435(1 Mar 1975).

After a brief outline of the main features of the correlation time-of-flight method a digital filtering technique based on the additional use of an uncorrelated pseudo-random binary sequence is quantitatively discussed with respect to the parameters controlling the gain factor. This technique turns out to be useful in cases where a huge nuisance peak is present in the system response. (auth)

3589 HIGH-RESOLUTION CHARGED-PARTICLE SPECTROSCOPY WITH SIDE-ENTRY Ge(Li) DETECTORS IN THE ENERGY RANGE OF THE JUELICH ISOCHRONOUS CYCLOTRON. Riepe, G.; Protic, D.; Reich, J. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Instrum. Methods; 124: No. 2, 527-531(1 Mar 1975).

Planar Ge(Li) detectors of the side-entry type were produced and tested with protons of 44.1 MeV, deuterons of 62.9 MeV and alpha particles of 155.5 MeV. Overall resolution figures obtained for particles, elastically scattered on Au under $\theta_{lab} = 15°$ were 15.2, 27.7, and 60.8 keV (fwhm), respectively. Contributions affecting the resolution are discussed. (auth)

3590 INTERPRETATION OF MOESSBAUER SPECTRA WITH BROADENED LINES. Moerup, S.; Both, E. (Danmarks Tekniske Hoejskole, Lyngby). Nucl. Instrum. Methods; 124: No. 2, 445-448(1 Mar 1975).

The width, intensity and area of a Moessbauer line have been computed by numerical integration. The source and absorber lines are assumed to be Lorentzian. Accurate values are presented as a function of the absorber thickness together with analytical expressions valid for thin absorbers. Special attention is paid to asymmetric quadrupole-split ^{57}Fe spectra. It is shown that spectra of this kind are easily misinterpreted unless a very thin absorber is used. (auth)

3591 A SEVEN-DETECTOR ANGULAR-CORRELATION APPARATUS FOR THE STUDY OF SHORT-LIVED NUCLEI. Basinger, G. J.; Schick, W. C. Jr.; Talbert, W. L. Jr. (Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Physics). Nucl. Instrum. Methods; 124: No. 2, 381-387(1 Mar 1975).

A seven-detector γ–γ angular-correlation apparatus has been constructed to study short-lived fission product nuclei produced by the TRISTAN on-line isotope separator system. The apparatus employs either seven NaI(Tl) detectors or six NaI(Tl) detectors and one Ge(Li) detector. A 16 384-channel analyzer may be used in conjunction with a series of single-channel discriminators to measure correlations simultaneously on all cascades involving a single γ-ray transition. Alternatively, a buffer tape system may be used to record data simultaneously on all cascades in a decay scheme. The apparatus has been tested on cascades in ^{138}Ba from the decay of ^{138}Cs. The results for three direct and two skip cascades are consistent with the known spins of 2^+, 4^+, 4^+, and 3^+ for the levels at 1436, 1899, 2308 and 2446 keV in ^{138}Ba, respectively. In addition mixing ratios of 0.01 ± 0.03, $0.05^{+0.09}_{-0.12}$ and 0.10 ± 0.03 have been obtained for the transitions at 1009, 409, and 547 keV in this nucleus. (auth)

3592 DSA MEASUREMENTS WITH TWO-TARGET ARRANGEMENT. Antilla, A.; Keinonen, J.; Bister, M. (Helsinki Univ. (Finland). Dept. of Physics). Nucl. Instrum. Methods; 124: No. 2, 605-606(1 Mar 1975).

In Doppler-shift attenuation (DSA) measurements, which are based on the energy difference of the γ peaks measured at two angles at least, runs of many hours are usual. Consequently, the gain drift is a serious problem. Particularly in the determination of very short lifetimes ($\lesssim$ 1 to 30 fs) with the DSA method the peak position of the γ rays should be measured with high accuracy. A two-target arrangement which reduces the effect of the gain drift on the nuclear-lifetime values derived in DSA measurements is described. (auth)

High Energy Physics Instrumentation

Refer also to abstract 4568.

3593 (JINR–P10-8546) PROGRAM FOR CALCULATION OF THE EFFICIENCY OF THE RISC ELEMENTS. Ivanov, V. G.; Strizh, T. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The program is described intended for calculation of the efficiency of separate elements of RISC (relativistic ionization streamer chamber) which is located in a magnetic field. The program is of modular structure and is written in the FORTRAN language for the computer BESM-6. (auth)

3594 A STREAMER CHAMBER FOR DEEPLY INELASTIC LEPTON SCATTERING WORK. Heusch, C. A.; Lieberman, B.; Seiden, A. (California Univ., Santa Cruz (USA)). Nucl. Instrum. Methods; 124: No. 1, 165-173(15 Feb 1975).

The design, construction, and performance of a streamer chamber built for experiments where small cross sections necessitate the use of dense targets inside the chamber and the passage of hundreds of particles per memory time through the chamber are described. This chamber was used in conjunction with all peripheral equipment of the SLAC Streamer Chamber Facility. (auth)

3595 A METHOD OF DETERMINING CHARGED-PARTICLE BEAM COMPOSITION. Heusch, C. A.; Seiden, A. (California Univ., Santa Cruz (USA)). Nucl. Instrum. Methods; 124: No. 1, 175-183(15 Feb 1975).

A method is described which efficiently and precisely determines the relative content of electrons/positrons, muons, and

hadrons in a high-energy beam of charged particles over a wide momentum range. There is no discrimination between hadrons of a given charge and momentum. As an example, the determination of electron and pion contaminations in a 14 GeV SLAC muon beam, to a precision of $\sim 10^{-5}$ is cited. (auth)

3596 RECENT OBSERVATIONS AND MEASUREMENTS WITH HIGH-ACCURACY DRIFT CHAMBERS. Breskin, A.; Charpak, G.; Sauli, F.; Atkinson, M.; Schultz, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Instrum. Methods; 124: No. 1, 189-214(15 Feb 1975).

Several recent measurements in high-accuracy drift chambers are described, in particular on the detailed behavior of the drift in strong magnetic fields, on the multitrack separation, and on the rate dependence of efficiency and pulse height. (auth)

3597 A SYSTEM OF MULTIWIRE PROPORTIONAL CHAMBERS FOR A LARGE APERTURE SPECTROMETER. Cavalli-Sforza, M.; Goggi, G.; Piazzoli, A.; Rossini, B.; Scannicchio, D. (Parvia Univ. (Italy). Istituto di Fisica). Nucl. Instrum. Methods; 124: No. 1, 73-82(15 Feb 1975).

Five large multiwire proportional chambers, ranging in size from 1.3×0.8 m^2 to 2.6×1.3 m^2, were built for a magnetic spectrometer in use at the Stanford SPEAR I e^+e^- storage ring. The design and construction problems raised by the large size of the chambers is discussed and the solutions that were adopted are described. Results of efficiency and uniformity tests are also given. (auth)

3598 A FLASH TUBE CHAMBER SUITABLE FOR USE AT HIGH REPETITION RATES. Chaney, J. E.; Breare, J. M. (Durham Univ. (UK)). Nucl. Instrum. Methods; 124: No. 1, 61-71 (15 Feb 1975).

Methods of reducing the recovery time of flash tubes by the addition of small amounts of molecular gas to the neon-helium gas mixture are described. The recovery time can be reduced from 300 ms for the tubes without additives to 0.6 ms for tubes at high pressure containing 2% of methane. The sensitive time is also reduced by the added gases, usually to times of a few microseconds, but further control of the sensitive time can be obtained by the application of alternating clearing fields. Apart from laboratory tests of the tubes using cosmic ray triggers, a flash tube chamber of 128 tubes, containing 30 –70 neon-helium plus 1% methane, have been tested at rates up to 50 pulses per second in an electron beam. The digitized signals from the tubes were large enough to interface directly with a computerized CAMAC system. It was shown that the tubes had an internal efficiency of greater than 97% under these conditions and that they had no memory of previous events even at the highest rate tested. (auth)

3599 BEHAVIOR IN MAGNETIC FIELD AND SPATIAL RESOLUTION OF A DRIFT CHAMBER WITHOUT ELECTRIC FIELD SHAPING. Sadoulet, B.; Litke, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nucl. Instrum. Methods; 124: No. 2, 349-357(1 Mar 1975).

Results on the behavior in a magnetic field parallel to the sense wires and the spatial resolution of a drift chamber with relatively short drift length (7.5 mm) but without electric field shaping are presented. This chamber operates quite well for a field as high as 15 kG, and the spatial resolution is better than ± 100 μm over the major part of the chamber for normally incident tracks. At 4 kG results are given on the spatial resolution as a function of the incident angle. (auth)

3600 THE ALIGNMENT OF FLASH TUBE TRAYS IN A LARGE MAGNETIC SPECTROGRAPH. Ayre, C. A.; Baxendale, J. M.; Daniel, B. J.; Goned, A.; Piggott, J. L.; Thompson, M. G. (Durham Univ. (UK)). Nucl. Instrum. Methods; 124: No. 2, 335-339(1 Mar 1975).

The method used for the alignment of flash-tube trays in the Durham 300 t magnetic spectrograph is discussed. The technique is also applicable to arrangements of wire spark chambers and drift chambers. The method illustrates the importance of having an odd number of trajectory defining elements in the experimental arrangements. (auth)

3601 OPERATION SYSTEM FOR A 50,000-WIRE PROPORTIONAL CHAMBER DETECTOR. Bell, W.; Chesi, E.; Cooper, R.; Fischer, H. G.; Fluegge, G.; Frehse, H.; Gottfried, Ch.; Heck, B.; Innocenti, P. G.; McLaren, I. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Instrum. Methods; 124: No. 2, 437-444(1 Mar 1975).

A multiparticle spectrometer at the CERN Intersecting Storage Rings is equipped with a multiwire proportional chamber detector. The trigger, data acquisition, and monitor systems of the detector are described. (auth)

3602 THE HIGH-DENSITY MULTIWIRE DRIFT CHAMBER. Jeavons, A. P.; Charpak, G.; Stubbs, R. J. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Instrum. Methods; 124: No. 2, 491-503(1 Mar 1975).

A multiwire proportional chamber, with a high-density drift space attached, has been developed as a position-sensitive detector for non-ionizing radiation. A chamber with a 5 g/cm^3 drift space, comprising a lead-bismuth matrix of 1 mm square holes on a 1.5 mm pitch has been investigated. For 0.66 MeV photons a detection efficiency of 5%, combined with a spatial resolution of 1.3 mm fwhm, is obtained. Much higher efficiencies are possible. A theoretical analysis of the detection efficiency as a function of photon energy is presented. It agrees well with experimental results. The chamber offers new possibilities for photon and neutron detection, and as a shower detector for high-energy particles. (auth)

3603 A BALLOON-BORNE IONIZATION SPECTROMETER WITH VERY LARGE APERTURE FOR THE DETECTION OF HIGH ENERGY COSMIC RAYS. Atallah, K.; Cleghorn, T. F.; Modlinger, A.; Schmidt, W. K. H. (Max-Planck-Institut fuer Physik und Astrophysik, Garching; Muenchen (F. R. Germany). Inst. fuer Extraterrestrische Physik). Nucl. Instrum. Methods; 124: No. 2, 461-476(1 Mar 1975).

A balloon experiment which was used to determine the chemical composition of very high energy cosmic rays up to and beyond 100 GeV/nucleon is described. The detector has a geometric factor of 1 m^{2}sr and a total weight on the balloon of 2100 kg. The apparatus consisted of an ionization spectrometer, spark chambers, and plastic scintillation and Cherenkov counters. It was calibrated at CERN up to 24 GeV/c protons and at DESY up to 7 GeV/c electrons. In October 1972 it was flown successfully on a stratospheric balloon. (auth)

Radiometric Instruments

Refer also to abstracts 3635–3637 and 4166.

3604 AUTOMATIC MEASUREMENT AND CONTROL OF PARAMETERS OF HIGH-TEMPERATURE GAS FLOW BY MEANS OF X RAYS. Stravinskas, A. B.; Matyukas, A. A. L. A. (Inst. of Physical-Technical Problems in Energy, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 3: No. 82, 127-139(1974). (In Russian).

After passing the flow, the radiation is transformed into an electrical signal by means of a luminescent-photoelectronic transformer. The signal of the parameter being measured is separated by a functional arrangement. A compensating channel, identical to the main one, is included in the functional arrangement for accuracy. The x ray scans the flow vertically to its axis with the help of an automatic coordinative device; distribution of the parameter across the flow is derived. The main analytical equations of the method are analyzed. A system is proposed for peak-holding temperature control at complete combustion, together with an analysis of corresponding equations. (auth)

3605 ION-INDUCED X-RAY SPECTROSCOPY AS A METHOD TO DETERMINE THE DEPTH DISTRIBUTION OF TRACE ELEMENTS. Pabst, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Muenchen (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 1, 143-147(15 Feb 1975).

The possibilities to determine the depth distribution of an element by ion-induced x-ray spectroscopy by means of measurements at several target orientations are investigated. The variation of x-ray yield with target orientation is calculated for some given profiles. The shape of these curves is compared to experimental results. It is shown that a Gaussian concentration profile can be located, but that the shape of the profile is not well resolved. (auth)

3606 A TTL SYSTEM PROGRAMMER FOR CYCLIC ACTIVATION ANALYSIS. Meggitt, G. C. (Royal Military Coll. of Science, Shrivenham (UK)). Nucl. Instrum. Methods; 124: No. 2, 455-459(1 Mar 1975).

A programming unit, using TTL logic, has been designed for cyclic activation analysis. The unit is capable of timing activation sequences over a wide range with an accuracy of better than 1%. (auth)

3607 CONVERSION OF A CONTINUOUS TIME SPECTRUM INTO A LINEAR ONE AS AN INFORMATION TRANSMISSION TECHNIQUE IN THE PULSE NEUTRON LOGGING. Dyuba, V. N.; Romanovskii, V. F. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 141-152 of Skvazhinnye generatory neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

A method for the cable transmission of time spectrum during work with a pulsed neutron source with conversion of the con-

tinuous time spectrum into a linear one was examined. The circuit of the converter used in the IGN-6 is reported. The operation of the converter is illustrated by a time spectrum obtained by it. It was shown that the use of this device significantly reduces the distortion of the spectrum studied in delayed plotting from 0 to 1000 μsec. (tr-auth)

3608 OPTIMIZATION OF MEASUREMENT RANGES IN PULSE NEUTRON LOGGING. Rezvanov, R. A.; Bespalov, D. F.; Bulatov, A. V. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 166-178 of Skvazhinnye generatory neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The two- and multichannel time measurement regimes using the pulsed neutron method were examined. The optimum regimes were determined from the minimum error of the desired decay decrement of the registered radiation intensity with time. The arrangement and the length of the time window for the two-channel regime and the number of channels and measurement time for one channel in multichannel regime are proposed. (tr-auth)

3609 CHARACTERISTIC FEATURES OF PULSE INSTRUMENTATION FOR NEUTRON WELL LOGGING. Bespalov, D. F.; Gordeev, Yu. I.; Dolgin, M. G.; Nikulin, B. A.; Putkaradze, L. A. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 192-200 of Skvazhinnye generatory neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The principal advantages of logging with neutron generators opens new possibilities for the solution of important problems of elementary analysis of rocks permeable to logging and particularly to the determination of the concentration of useful minerals in them. Methods based on the registration of γ radiation of capture neutrons and induced activities has the greatest possibilities for the determination of the elementary composition of rocks. The mean lifetime of thermal neutrons is tightly bound with the geological characteristics of the rocks. Therefore apparatus for the study of ore boreholes should have extensive capacity for the measurement of different forms of radiation. The parameters of apparatus working in three different regimes are examined. (tr-auth)

3610 THE IGN-4 PRODUCTION SYSTEM FOR EXPLORING DEEP OIL AND GAS WELL BY MEANS OF PULSE NEUTRON–NEUTRON LOGGING. Avanesov, V. M.; Bespalov, D. F.; Gol'dshtein, L. M.; Grishaev, A. I.; Kushnir, A. G.; Khaitovich, A. N. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 10-37 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The complex of the commercial IGN-4 apparatus is described. The apparatus was designed for exploring deep petroleum and gas wells by the pulse neutron-neutron logging method. The operating principles of the logging device and the ground-level control panel are described. The principal circuits of the registration unit, the unit for forming reference pulses, and the unit for pulsed-regime control of the operation of the accelerating tube UNG-I of the logging device are described. The circuits of the counting rate meter of the ground-level control panel are also given. The construction of the basic part of the logging device, the neutron emitter, is described. The basic technical specifications of the ING-4 are tabulated. (tr-auth)

3611 IGN-6M-TYPE MINIATURE PULSE NEUTRON LOGGING INSTRUMENT. Bespalov, D. F.; Dydychkin, V. N. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 38-81 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

Some design characteristics of the logging neutron generator IGN-6M for study of bore-holes using a sounding tube for pulse neutron logging were examined. The electrical circuits of the instrument are described. A brief analysis is given of the operation of the high-voltage power supply for the NT-16 accelerating tube. (tr-auth)

3612 PULSE NEUTRON LOGGING INSTRUMENTATION FOR EXPLORING EQUIPPED WELLS. Bespalov, D. F.; Krivoplyasov, A. M. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 52-64 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The results of research on the development of a logging neutron generator for the study of wells equipped with submerged oil insert pumps are discussed. The functioning of the principal electrical circuits is described, and the study of logging and laboratory tests on stratum models is discussed. (tr-auth)

Miscellaneous Instruments

Refer also to abstracts 2971, 5370, and 5383.

3613 (AERE-R-7914) CAMAC DIGITAL OUTPUT SYSTEM FOR THE MS5 MASS SPECTROMETER. Foster, E.; Hale, F. H. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jan 1975. 19p. Dep. NTIS (US Sales Only) $4.00. HMSO 50 pence.

A system is described which eliminates the usual ruler measurement of recorder chart output from the MS5 mass spectrometer. A new amplifier system is used together with a digital voltmeter and the CAMAC system to find the maxima and minima that occur in the output as the mass spectrum is scanned. The data values recorded are limited to peak and valley readings so that only a small amount of punched paper tape is produced. A printed record and chart recorder output are obtained at the same time. The method was extensively tested using National Bureau of Standards and natural materials and the results were found to be slightly closer to the accepted values for the materials used than the corresponding recorder chart results. The amount of time saved by the system has already fully justified its installation and considerable further development is possible. (auth)

3614 (AGC-3482) NERVA NRXA-ICF INSTRUMENTATION ENVIRONMENTAL PERFORMANCE TEST OF ROSEMOUNT RESISTANCE TEMPERATURE TRANSMITTERS, PLATINUM TYPE, MODEL 134EB-250 AND MODEL 134EB-1.86. (Component Evaluation Labs., El Monte, Calif. (USA). Electronic Div.). 31 Oct 1963. 35p. Dep. NTIS $4.75.

The purpose of this test report is to define procedures used and results obtained during performance of the NERVA NRX-A-ICF Instrumentation Environmental Performance Test program on four Rosemount Resistance Temperature Transmitters, Platinum Type: three each Model 134EB-250, and one each Model 134EB-1.86. The tests included medium temperature, low temperature, temperature shock, shock, humidity, and vibration. (WHK)

3615 (CEA-N-1700, pp 160-161) CHARGE EXCHANGER FOR POLARIZED SOURCE. Beurtey, R.; Burgei, R.; Ropert, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A device has been built to achieve ionization of polarized atoms by charge exchange in a plasma generated by a duoplasmatron and confined in an axial magnetic field. (auth)

3616 (PTB-FMRB-59) PRELIMINARY INVESTIGATION OF A NEUTRON INTERFEROMETER WITH A BIPRISM. Friedrich, H.; Heintz, W.; Piefke, F. (Physikalisch-Technische Bundesanstalt, Braunschweig (F. R. Germany). Forschungs- und Messreaktor). Dec 1974. 44p. (In German). Dep. NTIS (US Sales Only) $5.25.

In the course of further work to find out the reasons for the failure in the performance of a neutron interferometer with a biprism, the biprism was substituted by a quartz thread surrounded by a D_2O-H_2O mixture. Such threads can be produced without remarkable surface imperfections, thus avoiding formerly observed disturbances of the interference pattern. Problems of adjustment and of probe edges are discussed. (auth)

3617 (SAND-75-0181) REVIEW OF ELECTRICAL SWITCH DESIGN FACTORS FOR HIGH RELIABILITY SPACE AND WEAPONS APPLICATIONS. Cuthrell, R. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1975. Contract AT(29-1)-789. 18p. Dep. NTIS $4.00.

In order to improve the design of electrical switches for a particular type of operations, the designer must be aware of the physical and chemical phenomena which may be expected to affect their operation during their predicted life. He should be aware of the sources of contamination and he should design for contaminant exclusion or control, for cleaning, and for decreased sensitivity to contamination. The selection of contract materials and geometry should be consistent with the application, the switch design must be consistent with the circuit parameters, and the test procedures must be specified for the design. (auth)

3618 (TID/SNA-1646) AUTOMATIC RANGING PICOAMMETER, MODEL ME-8W. Operation and Maintenance. (EG and G, Inc., San Ramon, Calif. (USA)). 10 Jun 1966. 113p. Dep. NTIS $8.75.

The Model ME-8W Picoammeter is a wide range chopper stabilized current amplifier featuring all-solid state circuitry. Its 11 measuring ranges cover an input current span from $\pm 1 \times 10^{-12}$ to $\pm 1 \times 10^{-2}$ ampere full scale, in one decade steps. The ranging circuitry, in the automatic mode, selects the proper measuring range automatically and will track varying inputs throughout its 11 decade capability. Range selection may also be manually controlled from a remote location or at the front panel. Specifications,

operation, circuits, and maintenance procedures are presented. (WHK)

3619 EFFECTS ON FOCUSING PROPERTIES DUE TO FIELD FRINGING NEAR THE ENDS OF THE ELECTROSTATIC CYLINDRICAL MIRROR ANALYZER. Renfro, G.M.; Fischbeck, H.J. (Department of Physics and Astronomy, The University of Oklahoma, Norman, Oklahoma 73069). Rev. Sci. Instrum. 46: No. 5, 620-624 (May 1975).

The electrostatic potential field has been calculated numerically near the ends of the electrostatic cylindrical mirror analyzer. The effects of various guard ring configurations on the field distortion are calculated. The trajectories of electrons passing through the guarded and unguarded fields are calculated, and it is shown how field distortions influence the focusing properties of the analyzer. A coincidence spectrometer is proposed, based on the action of guard rings upon the fringing field. (auth)

3620 INTERFACING A MULTICHANNEL ANALYZER TO A MINICOMPUTER. Barclay, T. R.; Cloutier, R. J.; Watson, E. E.; Gilliam, P. L. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Medical Div.). Nucl. Instrum. Methods; 124: No. 1, 281-283(15 Feb 1975).

This report describes the modifications required and the interface circuitry needed to route the output of a Nuclear Data Model 2200 multichannel analyzer directly to a Digital Equipment Corporation PDP 11/20 computer. The analyzer's output then becomes acceptable as input into any computer program written in BASIC language. (auth)

3621 OPTIMIZATION OF THE SLIDING-SCALE METHOD FOR THE ADC STATISTICAL EQUALIZATION. Abbattista, N.; Impedovo, S.; Marino, D.; Mirizzi, N. (Bari Univ. (Italy). Istituto di Fisica). Nucl. Instrum. Methods; 124: No. 1, 185-188(15 Feb 1975).

The error ϵ_k associated with the counts stored in the kth channel of an amplitude multichannel analyzer (MA) is given by $\epsilon_k = [f(V)]_{V = \chi_k,\ id} (l_k - 1) + [df/dV]_{V = \chi_k,\ id} X (\chi_k - \chi_{k,id}) l_k$, where f(V) is the amplitude probability density function we want to measure, l_k is the width of the kth channel, 1 the corresponding one of an ideal MA with same nominal resolution; χ_k, $\chi_{k,id}$ are, respectively, the centroid coordinates of the kth channel of the actual and of the ideal MA. The width of the kth channel is averaged on the M channels following it; this fact involves two inconveniences: 1) if one wants to classify the signals in N channels, the actual converter capacity must be expanded to N + M channels; 2) the method efficiency (and particularly its dependence on M) is connected to the type of converter (e.g., multidiscriminator converters, successive approximations, Wilkinson's ...). In this work a particular way is suggested of realizing the sliding-scale method that has the following advantages; a) the errors ϵ_k are statistically vanishing, b) the above mentioned inconveniences are overcome. (NL)

3622 A NEUTRON MONOCHROMATOR SYSTEM CONSISTING OF DEFORMED CRYSTALS WITH ANISOTROPIC MOSAIC STRUCTURE. Freund, A. (Institut Max von Laue–Paul Langevin, 38–Grenoble (France)). Nucl. Instrum. Methods; 124: No. 1, 93-99(15 Feb 1975).

Based on a detailed diffraction study of a great number of monochromator crystals a new type of neutron monochromator is proposed. The large crystal plates normally used will be replaced by an ensemble of well oriented smaller crystals which have been preselected with respect to their reflecting properties. These elements are cold-worked crystals with an anisotropic but homogeneous distribution of the mosaic spread. Preliminary investigations of the neutron reflecting properties of such crystals are presented. (auth)

3623 A VERSATILE NEUTRON DIFFRACTOMETER. Boeuf, A.; Gobert, G.; Rustichelli, F. (Institut Max von Laue–Paul Langevin, 38–Grenoble (France)). Nucl. Instrum. Methods; 124: No. 2, 533-540(1 Mar 1975).

A versatile neutron diffractometer, installed at the end of a neutron guide at the High Flux Reactor in Grenoble, is described. The facility consists essentially of two cylindrical tables which support the two rotation axes and can move on a very flat marble surface by air cushions. In addition, a contribution to the versatility of the instrument is the positioning of the radiation shielding around the working area (and not, as is usually done, around the neutron monochromator). Furthermore a six meter long neutron flight distance in front of the facility allows an easy change of the neutron beam divergence, up to values as small as one minute. Following a description of the diffractometer and of the characteristics of the available neutron beams, the different performances are presented. These include characterization of conventional and new neutron monochromators, rapid test of quality of samples to be used in other neutron experiments, verification of molecular alignment in liquid crystals, and simulation of high- and variable-resolution neutron-diffraction conditions. In addition, neutron Laue pictures and neutron topographs can be taken on special samples. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 3058 and 5311.

3624 (K-OA-2707) REMARKS ON WORLD-WIDE URANIUM ENRICHMENT CAPACITY PLANS OUTSIDE OF THE UNITED STATES. Levin, S. A. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 30 Apr 1975. Contract W-7405-eng-26. 7p. (CONF-750424-3). Dep. NTIS $4.00.

From American Nuclear Society meeting on commercial nuclear fuel technology today; Toronto, Ontario, Canada (27 Apr 1975).

The review is based on news items and articles which have appeared in the public literature. The projects discussed include Triparticle and Eurodif. The plans of other countries are also included. (TFD)

3625 (UCCND-CSD-10) ANALYSIS AND CALCULATION OF SPECIES SEPARATION IN A SUPERSONIC FLOW OF A GAS MIXTURE THROUGH A CURVED SHOCK WAVE. Harris, W. L.; Tunstall, J. N.; Burris, J. H. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). Feb 1975. Contract W-7405-eng-26. 118p. Dep. NTIS $5.45.

The technical accomplishments of efforts to synthesize existing theoretical models of shock wave phenomena in order to predict species separation in gas mixtures in supersonic flow through curved, two-dimensional shock waves are summarized. The results reported are consistent with the structure of the shock being governed by the Navier-Stokes equations. The implication is, in this case, that the flow is not rarefied. The results are not limited by mass ratio or mole fraction of the species in the binary mixture. The species are assumed to be nonreacting (chemically inert). The effects of Mach number, initial mole fraction, Reynolds number, mass ratio, and shock standoff distance are described. Details of the required digital computations, including a documented numerical code, are also described. (auth)

3626 (UCCND-CSD-INF-16) MATHEMATICAL MODEL OF DIFFUSION OF UF_6 AND A LIGHT AUXILIARY. Tunstall, J. N. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 4 Dec 1974. Contract W-7405-eng-26. 23p. (CONF-741214-3). Dep. NTIS $4.25.

From workshop on gas dynamic problems in isotope separation; Albuquerque, New Mexico, USA (4 Dec 1974).

A mathematical model, which treats the radial convection and diffusive fluxes of the ternary gas mixtures of interest when the tangential convective velocity is specified and independent of turning angle, is described. The numerical technique employed is outlined, and results showing the effects on separation by varying inlet mixture composition, inlet pressure, and the magnitude of the tangential velocity are shown. Also shown are comparisons with experiment of a similar model reported by Dr. W. Ehrfeld to illustrate that this theory does not completely describe the magnitude of the separation of Becker's separation nozzle. (auth)

3627 He–JET ON-LINE ION SOURCE OF THE UNISOR MASS SEPARATOR. Schmidt-Ott, W. D.; Mlekodaj, R. L.; Spejewski, E. H.; Carter, H. K. (UNISOR, Oak Ridge, Tenn. (USA)). Nucl. Instrum. Methods; 124: No. 1, 83-91(15 Feb 1975).

A new He-jet-capillary-skimmer-ion source system was connected to the UNISOR mass separator. On-line measurements were carried out using reaction recoils from ^{12}C and ^{14}N beams incident on targets of ^{142}Nd, ^{141}Pr and natural Ag. Absolute efficiencies were measured for the He-jet-capillary system only, the He-jet-capillary plus skimmers and also for the total on-line system. Collections in the focal plane of the separator under optimal conditions gave an overall efficiency of 0.7% for ^{115}Te and $^{114,115}Sb$. A total efficiency of ~0.1% was measured for $^{150,151}Dy$. The influence of various parameters on the system performance was investigated. These parameters were (1) additives to the helium, (2) cooling of the skimmers, (3) a +50 kV potential between the reaction and collection chambers, (4) two different geometries for a hollow cathode ion source, and (5) two different diameters of the transport capillary. (auth)

3628 LASER INDUCED PHOTOCHEMICAL ENRICHMENT OF CHLORINE ISOTOPES. Lamotte, M. (Bordeaux–1 Univ., 33–Talence (France)); Dewey, H. J.; Keller, R. A.; Ritter, J. J. (National Bureau of Standards, Washington, D. C. (USA)). Chem. Phys. Lett.; 30: No. 2, 165-170(15 Jan 1975).

Chlorine isotopic abundances were significantly altered by laser induced, selective excitation of particular isotopic species of thiophosgene followed by a chemical reaction between the electronically excited thiophosgene and diethoxyethylene. The concentration of ^{35}Cl in thiophosgene was changed from 75% to 64% or 80% depending upon the isotopic species initially excited. (auth)

3629 ISOTOPE ENRICHMENT OF METAL IN PROCESS OF PULSED ELECTROTRANSFER. Troitskii, O. A.; Spitsyn, V. I.; Glazunov, M. P.; Nifant'eva, R. M. (AN SSSR, Moscow. Inst. Fizicheskoi Khimii). Dokl. Akad. Nauk SSSR; 218: No. 4, 894-895 (1 Oct 1974). (In Russian).

A study was carried out on the change in isotopic ratios during pulsed electrotransfer. As a starting material, use was made of polycrystalline zinc wire 99.98% pure containing a natural mixture of the isotopes: ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn and ^{70}Zn. An estimate of the degree of isotopic enrichment was carried out from a mass spectrometric analysis on the change in ratio of stable isotopes $^{64}Zn/^{68}Zn$. Enrichment in the ^{64}Zn isotope was found. This result was confirmed by activation analysis. (tr-SJR)

Isotopic Power Sources

Refer also to abstracts 3288–3290.

3630 (BNWL–1845-6) PACIFIC NORTHWEST LABORATORY QUARTERLY REPORT TO SPACE NUCLEAR SYSTEMS PROGRAMS FOR OCTOBER–DECEMBER 1974. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1975. Contract AT(45-1)-1830. 23p. Dep. NTIS $4.00.

The short-term compatibility tests with SrF_2 containing controlled levels of impurities have been completed and the test couples evaluated. With a few exceptions, the addition of impurities to the fluoride increased the metal attack. Evaluation of the short-term $^{90}SrF_2$ test couples is approximately 60% completed. Examination of the remaining couples should be completed in January, 1975. Dissolution rate measurements with nonradioactive SrF_2, $SrTiO_3$ and Sr_2TiO_4 have been completed. The results show that in general, Sr_2TiO_4 dissolves at the highest rate, $SrTiO_3$ at the slowest rate and SrF_2 at an intermediate rate. The dissolution rate for each compound is highly dependent on the composition, surface area and thermal history. The thermodynamic analysis of the $^{90}SrF_2$-W system has been completed. The final version of the program plan has been submitted to Space Nuclear Systems (SNS). (auth)

3631 (BNWL-1845-7) PACIFIC NORTHWEST LABORATORY MONTHLY REPORT TO SPACE NUCLEAR SYSTEMS DIVISION FOR JANUARY 1975. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-1830. 32p. Dep. NTIS $4.00.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and double encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. Research progress is reported on the following: (1) long-term SrF_2 compatibility data; (2) chemical and physical property data on $^{90}SrF_2$; and (3) capsule property data such as external corrosion resistance, crush strength, etc. (auth)

3632 (BNWL-1845-8) PACIFIC NORTHWEST LABORATORY MONTHLY REPORT TO SPACE NUCLEAR SYSTEMS PROGRAM FOR FEBRUARY 1975. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1975. Contract AT(45-1)-1830. 7p. Dep. NTIS $4.00.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and double encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general areas: long-term SrF_2 compatibility data; chemical and physical property data on $^{90}SrF_2$; and capsule

property data such as external corrosion resistance, crush strength, etc. The current program is designed to provide the required information. (auth)

3633 (COO-2393-13) STANDARDIZED SPACECRAFT: A METHODOLOGY FOR DECISION MAKING. AMS Report No. 1199. Greenberg, J. S.; Nichols, R. A. (Princeton Univ., N. J. (USA). Dept. of Aerospace and Mechanical Sciences). 31 Dec 1974. Contract AT(11-1)-2393. 190p. Dep. NTIS $12.50.

As the space program matures, more and more attention is being focused on ways to reduce the costs of performing space missions. Standardization has been suggested as a way of providing cost reductions. The question of standardization at the system level; in particular, the question of the desirability of spacecraft standardization for geocentric space missions is addressed. The spacecraft is considered to be a bus upon which mission oriented equipment, the payload, is mounted. Three basic questions are considered: (1) is spacecraft standardization economically desirable; (2) if spacecraft standardization is economically desirable, what standardized spacecraft configuration or mix of configurations and technologies should be developed; and (3) if standardized spacecraft are to be developed, what power levels should they be designed for. A methodology which has been developed and which is necessary to follow if the above questions are to be answered and informed decisions made relative to spacecraft standardization is described. To illustrate the decision making problems and the need for the developed methodology and the data requirements, typical standardized spacecraft have been considered. Both standardized solar and nuclear-powered spacecraft and mission specialized spacecraft have been conceptualized and performance and cost estimates have been made. These estimates are not considered to be of sufficient accuracy to allow decisions regarding spacecraft mix and power levels to be made at this time. The estimates are deemed of sufficient accuracy so as to demonstrate the desirability of spacecraft standardization and the methodology (as well as the need for the methodology) which is necessary to decide upon the best mix of standardized spacecraft and their design power levels. (auth)

3634 (DPST-75-128-3) ^{238}Pu FUEL FORM PROCESSES. Savannah River Laboratory Monthly Report. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Mar 1975. Contract AT(07-2)-1. 53p. Dep. NTIS $5.75.

PPO pellet fabrication studies showed that: increasing shard pre-sintering temperature of high-sinterability feed material from 1150°C to 1200°C reduced hot-press density and coarsened inter-shard porosity; and a reduction in time of post-hot-pressing heat treatment from 12 to 6 hr at 1440°C resulted in fully re-oxidized PuO_2 but produced an undesirable reduction in grain size (from 10 to 3 μm). Investigation continued on variations in sinterability of SRP $^{238}PuO_2$ feed. The following were observed: surface area of calcined PuO_2 is not significantly affected by particle size or morphology; and $^{238}PuO_2$ feed from current production campaign with tighter process controls has larger particles, contains fewer fines, and has a narrower particle size distribution than normal (old) or high-sinterability feed lots. Shards fabricated by the current process can meet Milliwatt purity specifications if iron, nickel, and silicon content of feed used is selected from the low end of the values normally observed in SRP $^{238}PuO_2$. (auth)

Radiation Sources

Refer also to abstracts 3432, 3607, 3608, and 3611.

3635 INVESTIGATION INTO MINIATURE PULSE HIGH TENSION SOURCES OF ACCELERATING VOLTAGE. Dydychkin, V. M. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 88-99 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The design characteristics of a high-voltage pulse source power supply for an accelerator neutron tube for limiting the size of the source by the dimensions of the logging device were examined. An engineering method for the calculation of the simple discharge circuit with pulse transformers and approximate calculation of the basic parameters of these transformers are proposed. (tr-auth)

3636 SOME PROBLEMS ON DESIGNING HIGH-VOLTAGE SINUSOIDAL TRANSFORMERS FOR OPERATION IN NEUTRON GENERATORS INTENDED FOR WELL LOGGING. Dydychkin, V. N.; Kashina, N. L. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Yadernoj Geofiziki i Geokhimii, Moscow (USSR)). pp 111-118 of Neutron Generators for Well Logging (Collection of Articles). Moscow; Vsesoyuznyj Nauchno-Issledovatel'skij Institut Yadernoj Geofiziki i Geokhimii (1973). (In Russian).

The operation of high-voltage transformers in neutron logging generators is examined. On the basis of a theoretical examination of the characteristics of the resonance regime of the transformers, formulas and histograms are recommended for the engineering calculation of the transformer working in this regime. (tr-auth)

3637 A MODIFICATION OF THE UNIVERSAL NEUTRON GAS-FILLED TUBE. Bespalov, D. F.; Bessarabskii, Yu. G.; Vojtsik, L. R.; Mints, A. Z. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 65-80 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The construction and characteristics of a new gas-filled neutron tube for the logging neutron generator UNG-3 are described. The tube generates an integral flux of 10^8 n/sec. The working regime is either pulsed (in the high-voltage doubling circuit) or continuous. (tr-auth)

3638 NT-16 AND NT-19 MINIATURE PULSE NEUTRON TUBES. Bespalov, D. F.; Vasin, V. S.; Ovsyannikov, S. B. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 81-87 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoj Geofiziki i Geokhimii (1973). (In Russian).

The construction and power supply circuits for the neutron tubes NT-16 and NT-19 are described. The tubes are used in miniature neutron generators, having a diameter of less than 42 mm. The parameters of the accelerating tube are reported. (tr-auth)

3639 GENERATION OF MICROSECOND NEUTRON PULSES BY MEANS OF THE UNG-TYPE GAS-FILLED NEUTRON TUBE. Bespalov, D. F.; Bessarabskii, Yu. G.; Mints, A. Z. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 100-110 of Skvazhinnye Generatory Neitronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian).

The construction of the gas-filled neutron tube designed for work in a short-pulse regime (3 to 10 μsec) with following frequency of 100 to 1000 Hz is described. The circuit for the power supply of the ion source is also described. A neutron yield of 10^5 n/imp with a steep trailing edge was obtained at these pulse durations. (tr-auth)

Design and Fabrication

3640 NEW SOURCES FOR AFTER-LOADING GYNECOLOGICAL THERAPEUTIC UNITS. Mangliar, F. (MTA Izotop Intezete, Budapest). Izotoptechnika; 18: No. 1, 21-24(Jan 1975). (In Hungarian).

Spherical stainless steel welded sources of type CoS-3H-2 with a dia of 3.3 mm are described. Leak testing of the source is discussed. (auth)

Industrial Uses

Refer also to abstracts 3068, 3690, and 3759.

3641 (AD-786807) PROCEEDINGS OF THE SCIENTIFIC-TECHNICAL CONFERENCE ON THE USE OF IONIZING RADIATION IN THE NATIONAL ECONOMY. Issue 3. 30 Jan 1974. Translated from pp 2-313 of Doklady Nauchno-Tekhnicheskoi Konferentsii po Ispolzovaniyu Ioniziruyushchikh Izluchenii v Narodnom Khozyaistve, Issue 3, Tula, 1970. 412p. NTIS $10.50.

Radiation chemistry and technology of food products, the hygienic evaluation of irradiated food products, and the gamma facilities of the food industry are discussed. The effect of ionizing radiation on fruit tissue disorders, fruit maturation rate, microflora count in fruits and vegetables, cryoconcentration of fruit juices, and beef and pork storage life is reported, along with related applications. The hygienic monitoring of irradiated fruits, fish, and the daily diets of population groups is described. Gamma facility operation and economics and the use of ionizing radiation in reducing noise levels in semiconductor devices and enhancing the heat resistance of ball-bearings and packing greases, as well as increasing fruit tissue permeability are reported. (GRA)

3642 (CEA-N-1780) POTENTIAL APPLICATIONS FOR ^{252}Cf. Berger, R. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). Jan 1975. 21p. (In French). Dep. NTIS (US Sales Only) $4.25.

An analysis is presented of three American surveys on potential markets for devices using ^{252}Cf. According to this information for

the present ^{252}Cf price and taking a probability level of 0.5, the business value of ^{252}Cf devices should increase from $2.3 million (FF 11.4 million) in 1974 to $13 million (FF 65 million) in 1980. The cumulative 1974 to 1980 U. S. totals involve the sale of more than 1,000 devices for a total of $49 million (FF 245 million). The foreign market may equal or exceed these figures. Twenty five end uses in eight market segments are now recognized. On-stream process control and nuclear materials assay will account for more than half on the cumulative 1974 to 1980 market for ^{252}Cf devices. Two major industries, nuclear power and Portland cement, appear to be good potential customers for these devices. (auth)

3643 (INIS-mf-1559) STUDIES ON THE CONSTRUCTION OF A PROTOTYPE IRRADIATOR ON A SEMI-INDUSTRIAL SCALE AND FOR RESEARCH PURPOSES FOR ONION TREATMENT IN NORTHEAST BRAZIL. Dall'Olio, A.; Meira e Sa Junior, J. P.; de Alencar Menezes, M. O.; de Almeida, L. M.; da Silva, H. D.; da Silva, C. J. G. C. (Pernambuco Univ., Recife (Brazil). Centro de Energia Nuclear). 1973. 19p. (In Portuguese). INIS.

The applications of gamma radiation to typical regional problems, showing the necessity of decentralizing this type research are discussed. Emphasis was given to the study of a prototype irradiator economically suited for treating regional agricultural products, chiefly onions of Northeastern Brazil, and for research, with the possibility to reach an industrial scale. The low cost prototype studied shows among others the following characteristics: ease of construction, high dose uniformity, many independent irradiation channels, large spectrum of application, possibility of a continuous irradiation cycle, and flexibility as to the utilizable volume capacity for treatment per unit of time. This type of irradiator was planned to absorb the total volume of onions sold at the "Central de Abastecimento S/A" of Pernambu co, Brazil, or the total state of Pernambuco production only by increasing the source intensity and construction of this multiple purpose irradiator in the regions of onion production. (INIS)

3644 STUDY OF THE CORROSION OF AMALGAMS BY RADIOACTIVE TRACER METHOD. Madi, I.; Joo, P.; Bolyos, A. (Kossuth Lajos Tudomanyegyetem Izotop Laboratoriuma, Debrecen, Hungary). Izotoptechnika; 18: No. 1, 28-34(Jan 1975). (In Hungarian).

The effect of the dissolved depolarizers ($S_2O_8^{2-}$ I_3^-) on the corrosion of thallium and zinc amalgams labelled with ^{204}Tl and ^{65}Zn was studied. The determination of the rate constant, activation energy, and mechanism of the corrosion are described. (auth)

3645 INDUSTRIAL AND OTHER USES OF PHOTONUCLEAR REACTIONS. Veres, A. (MTA Izotop Intezete, Budapest). Izotoptechnika; 18: No. 1, 25-27(Jan 1975). (In Hungarian).

The reactions, their uses, and sources are described. (auth)

3646 INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Charlton, J. S.; Heslop, J. A.; Johnson, P. (Imperial Chemical Industrial Ltd., Billingham, Eng.). Phys. Technol.; 6: No. 2, 67-76(Mar 1975).

The organization of a team of scientists of different disciplines, within an industrial organization, to tackle industrial problems involving the use of radioisotopes for process control and analysis and for tracer techniques, is explained. A review of the uses of radioisotopes as a tool in industry is given including blockage and leak detection and level and interface measurement. The safety aspects of industrial use of radioisotopes is considered. (UK)

LIFE SCIENCES

Radiation Effects on Biochemicals

Refer also to abstracts 3757, 5809, and 5810.

3647 (COO-2403-3) EARLY STEPS IN PROTEIN SYNTHESIS AND THEIR REGULATION: A BACKGROUND STUDY RELATED TO THE BIOLOGICAL EFFECTS OF RADIATION. Progress Report, July 1, 1974–June 30, 1975. Zamecnik, P. C. (Massachusetts General Hospital, Boston (USA). John Collins Warren Labs.). 1975. Contract AT(11-1)-2403. 34p. Dep. NTIS $4.75.

The proposed program is an interwoven effort to study the details of the mechanism of protein synthesis in normal living systems and their alterations in the presence of oncogenic RNA viruses using the avian myeloblastosis virus as a model. Emphasis will be placed on determining the role of the primary structure of the viral RNA and of other factors required for the production of viral proteins in a cell-free system. Continued studies of the initial steps of protein synthesis where much specificity is determined by the tRNA: tRNA synthetase interactions will be carried out using biochemical and genetic techniques. (auth)

3648 (COO-3212-30) REDUCTION OF NUCLEOTIDES BY IONIZING RADIATION: URIDINE 5' PHOSPHATE, AND CYTIDINE 3' PHOSPHATE. Box, H. C.; Potter, W. R.; Budzinski, E. E. (Roswell Park Memorial Inst., Buffalo, N. Y. (USA). Dept. of Biophysics). 13 Dec 1974. Contract AT(11-1)-3212. 15p. Dep. NTIS $4.00.

Anions formed by the addition of an electron to the uracil base were observed in single crystals of the barium salt of uridine 5' phosphate x irradiated at 4.2°K. The hyperfine coupling tensor for the C_6-H proton was deduced from ENDOR measurements; the principal values are -59.12, -32.92 and -16.24 MHz. Similar measurements were made on single crystals of cytidine 3' phosphate. The principal values for the C_5-H proton hyperfine coupling in the anion formed on the cytosine base are -59.26, -33.98 and -14.68 MHz. (auth)

3649 INTERACTION OF DGMP RADICAL WITH CYSTEAMINE AND PROMETHAZINE AS POSSIBLE MODEL OF DNA REPAIR. Willson, R. L. (Brunel Univ., Uxbridge, Eng.); Wardman, P.; Asmus, K. D. Nature (London); 252: No. 5481, 323-324(22 Nov 1974).

The lethal action of ionizing radiation is thought to involve the formation of electrophilic species, many of which are free radical in nature, which interact with molecules such as nucleic acid. The protective effect of the nucleophilic compounds cysteamine and promethazine was attributed to their ability first to scavenge these species and second to reduce chemically free radical lesions, thereby resulting in their repair. Although the scavenging actions of cysteamine and promethazine towards several electrophilic intermediates were observed directly, their reaction with nucleic acid related free radicals was not. Experimental work is reported, which indicates that direct interaction between nucleophilic agents and free radicals produced in nucleic acid can occur rapidly. As these radicals are intermediates in lesion production the processes that occur constitute a repair mechanism. The experimental work involved pulse radiolysis, with optical and conductometric analysis; and involved the following reactions: pulse radiolysis of N_2O saturated solutions of thymidine, cytidine, adenosine, and guanoisine; and of slightly acid solutions of d GMP, and promethazine including N_2O saturated solutions. (UK)

3650 PHOTOSENSITIZATION OF NUCLEIC ACID CONSTITUENTS BY PROFLAVINE: NO_2 RADICALS DUE TO IMPURITIES. Cannistraro, S.; Lion, Y.; van de Vorst, A.; Calbert-Bacq, C. M. (Univ., Liege). Int. J. Radiat. Biol.; 26: No. 6, 589-592(Dec 1974).

Studies on photosensitization, photolysis, and radiolysis of many nucleic acid constituents in frozen solutions have repeatedly shown, among others, an ESR spectrum consisting of a triplet spread over 120G. However, the same kind of spectrum was also found in the ESR spectra induced by visible light and proflavine in frozen aqueous solutions of 2-naphthyl-β-D-glucopyranoside, suggesting that the corresponding free radical was not characteristic of the nucleic acid constituents. An investigation of the origin and nature of this signal proved unambiguously that the observed triplet did not come from free radicals induced in the nucleic acid constituents, but rather from nitrates or nitrites present as impurities in the different frozen solutions investigated. The impurities were associated both with the inorganic chlorides and with a sample of dUMP from one supplier. (UK)

3651 RADIOSENSITIZATION OF BIOLOGICALLY ACTIVE DNA IN CELLULAR EXTRACTS BY OXYGEN. Evidence That the Presence of SH-Compounds is Not Required. van Hemmen, J. J.; Meuling, W. J. A.; Bleichrodt, J. F. (Rijksverdedigingsorganisatie TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol.; 26: No. 6, 547-555(Dec 1974).

The radiosensitization by oxygen of biologically active bacteriophage DNA in bacterial extracts was studied. The oxygen-effect in such a system appeared not to be due or only to a minor extent to the presence of endogenous sulphydryl compounds. The components in a cell extract that enable oxygen and other sensitizers to sensitize DNA could not be destroyed by extremely high doses of γ radiation. (auth)

3652 DEGRADATION OF NUCLEIC ACID IN AQUEOUS SOLUTION BY IONIZING RADIATION. II. Analysis of the Contribution of Various Water Radicals to the Loss of Ultraviolet Absorption by Thymidylate Solutions During X Irradiation. Hayes, F. N.; Hoard, D. E.; Dean, P. N.; Goad, W. B. (Los Alamos Scientific Lab, NM). Int. J. Radiat. Biol.; 26: No. 6, 511-522(Dec 1974).

Experiments are described in which increasing concentrations of ammonium thymidylate, plus a variety of additional radical-scavenging compounds, were irradiated in aqueous solution with 250-kV x rays. In addition to hydroxyl radicals, both hydrogen atoms and hydrated electrons can contribute to chromophore destruction. Under some conditions, where an excess of tert-butyl alcohol was present to scavenge hydroxyl radicals, up to 80% of the observed chromophore damage could be attributed to the action of hydrated electrons. On average, about 65% of the dTMP-hydroxyl radical interactions, 75% of the dTMP-hydrogen atom interactions, and 67% of the dTMP-hydrated electron interactions taking place under each set of experimental conditions resulted in chromophore destruction. The mathematical treatment of the data, on which these conclusions were based, is described. (auth)

3653 INACTIVATION OF ENZYMES BY IRRADIATION WITH LOW-ENERGY ELECTRONS. Whitaker, F. M. East Lansing, MI; Michigan State Univ. (1974). 207p. University Microfilms Order No. 74-27,504.

Thesis (Ph. D.).

The interaction of high energy ionizing radiation with matter produces a flux of low-energy electrons. In order to study the biological damage produced by these electrons, thin films of enzymes were irradiated with electrons with an energy range of 20 to 2,000 eV. Two enzymes were used as indicators of biological damage: ribonuclease and trypsin. They were plated on either stainless steel disks, or the steel disks coated first with graphite. These samples were irradiated directly with electrons in a high vacuum. The stainless steel or graphite coated disks were coated with the enzymes by dipping them into bulk solutions of the enzymes, and then pulling them out slowly with an electric motor and pulley. This procedure deposited the surface layer of protein on the disk, and gave uniform films of molecular thickness. An o-ring sealed vacuum tank was built with a support table capable of holding 12 samples and rotating them one at a time beneath the electron gun. An electron gun was built which used a rare earth oxide-coated filament as an electron source. A 2.25-in. diameter area was irradiated on the sample disk, and a 2.00-in. area was assayed for enzymatic activity. The tryptic esterase activity was assayed using the BAEE assay, and the activity of the ribonuclease was determined by measuring its rate of ribonucleic acid. The inactivation cross section, sigma, was found to be energy dependent, and it increased rapidly with increasing energy from 20 eV up to a broad peak value in the electron energy range of 300–500 eV. Ribonuclease was most sensitive to 300 eV electrons, and trypsin was most sensitive to 500 eV electrons. With further increases in electron energy the inactivation rate decreased with increasing energy, but at a much slower rate than the initial rapid increase. The graphite coating was applied to the steel disks to test for a possible support material effect. A 40 percent reduction in the inactivation rate was observed for both enzymes on the graphite; however, a similar protective effect was observed for inactivation caused by irradiation with 254 nm UV light. Therefore, the protective effect observed on graphite is not unique to the electron inactivation process, and a possible explanation is offered in the text. The two most important results of this study are the fact that the enzymes are most sensitive to electrons in the 300–500 eV energy range, and that the two enzymes had different peak energies for

inactivation. A qualitative discussion is presented which postulates that this difference can be explained by the relative amounts of energy absorbed by electronic excitation, ionization, and excitation following ionization. Using published data for electron energy absorption by solid materials, the energy absorbed per molecule inactivated was determined. Using this data it was also shown that the energy absorbed per molecule inactivated approached a constant value just above the peak inactivation energy. For ribonuclease this energy was about 30 to 50 eV absorbed, and for trypsin it was about 50 to 100 eV absorbed per molecule inactivated. (Diss. Abstr. Int., B)

3654 EFFECT OF ^{60}Co-γ-RAYS ON THE INFRARED SPECTRA OF DNA. Karolyi, G.; Skapinyecz, J.; Somogyi, B.; Damjanovich, S. (Medical Univ., Debrecen, Hungary). Acta Biochim. Biophys. Acad. Sci. Hung.; 7: No. 2, 179-185(1972).

High polymer calf thymus DNA solutions have been investigated by infrared spectroscopy between 800 and 1700 cm^{-1}. Cobalt-60 γ irradiation (~10^4 kR) caused only a minor alteration in the infrared spectra, mainly due to the damage of different bases. Higher irradiation doses (~10^5 kR) increased the spectral changes at wavenumbers characteristic of certain bases. However those spectral parts characterizing the number of base-pairs remained practically unchanged after doses that produced degradation well detectable by viscosity measurements. (auth)

3655 PROBLEMS OF THE RADIATION BIOCHEMISTRY OF DNA. Mazurik, V. K. pp 7-40 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

A critical literature review is given of recent studies in the radiation biochemistry of DNA. The biochemical mechanisms of the interphase destruction of cells are first considered. The relation between the breakdown in the exchange of DNA and the biochemical indicators of radiation injury is discussed. Some contemporary concepts on the radiosensitivity of the biosynthesis of DNA are reviewed. (216 references) (JSR)

3656 ENZYMES AND POST-RADIATION METABOLISM OF DNA. Gaziev, A. I. pp 41-82 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

A critical review is presented of recent studies on enzymes and post-irradiation metabolism of DNA. The properties of the most important enzymes participating in the processes of recovery and reparation of radiation-injured DNA are discussed. The enzymes considered are DNA-ligase, DNA-polymerase, and desoxyribonuclease. The possible mechanisms for the reparation and degradation of damaged DNA in the cell are reviewed. (247 references). (JSR)

3657 RADIATION IMPAIRMENT OF THE EXCHANGE OF RIBONUCLEIC ACID. Paskevich, I. F. pp 83-105 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

Studies reported in the literature from 1966 to 1971 on the radiation impairment of RNA exchange were critically reviewed. The data presented on the biosynthesis of RNA in different organs and tissues show the great radiosensitivity of the processes of synthesis, transport, and preservation of the different classes of cellular RNA. (93 references). (JSR)

3658 EFFECT OF IONIZING RADIATION ON THE SYNTHESIS OF ALBUMIN. Biokhina, V. D. pp 106-129 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

A critical review is presented on studies on the effects of radiation on albumin synthesis. The topics discussed are the effect of radiation on the synthesis of albumin ferments, synthesis of specific albumins in irradiated organisms, changes in the qualitative state of resynthesizing albumin during radiation sickness, activation of amino acids during radiation sickness, effects of radiation on isolated albumin-synthesizing systems, synthesis of albumin fractions in the tissue cells of irradiated animals, and effects of ionizing radiation on the synthesis of albumin in nuclei irradiated in vitro. (114 references). (JSR)

3659 GLYCOPROTEINS OF THE BLOOD DURING RADIATION SICKNESS. Tutochkina, L. T.; Nesterova, T. A. pp 130-148 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

A critical review is presented of studies on the glycoproteins of the blood during radiation sickness. The topics discussed are changes in the albumin composition of the blood as a nonspecific reaction of the organism to injury, quantitative changes in blood albumins after irradiation, changes in the formation of blood albumins in the liver, and hypothesis on the humoral mechanism of the nonspecific stimulation of the formation of acute-phase albumins in the liver. (106 references). (JSR)

3660 BREAKDOWN OF THE DEAMINATION OF SOME NITROUS COMPOUNDS DURING RADIATION INJURY. Gorkin, V. Z.; Akopyan, Zh. I. pp 164-190 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

Studies on the possible mechanisms for the development of the breakdown of some fermentive reactions of deamination of biologically important nitrous compounds during radiation injury and other pathological conditions accompanied by the accumulation of lipid peroxides in the tissues are analyzed. Studies at the level of the complete organism, at the mitochondria level, and at the molecular level are reviewed. (103 references). (JSR)

3661 DEVELOPMENT OF STRUCTURAL-METABOLIC THEORY IN RADIOBIOLOGY (CASCADE HYPOTHESIS OF REGULATION ERRORS). Kuzin, A. M.; Paskevich, I. F. pp 261-268 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

The development of the cascade theory of metabolic effects of ionizing radiation is outlined and the three stages in the development of regulatory malfunctions of the body are described. The hypothesis is based on assumption that the degree of damage depends on the degree of integration of molecular, subcellular, and cellular regulatory mechanisms, on the irradiation dose, and on the time after irradiation. (21 references). (JSR)

3662 ACTION OF IONIZING RADIATION ON PROTEIN: RADICAL FORMATION IN L-HISTIDINE CRYSTALS. Westhof, E.; Flossmann, W.; Mueller, A. (Univ., Regensburg, Ger.). Int. J. Radiat. Biol.; 27: No. 1, 51-62(Jan 1975).

Radicals produced at temperatures between 77 K and 300 K by x irradiation of L-histidine · 2HCl crystals have been analyzed by electron spin resonance spectroscopy. The results are compared with previous findings with L-histidine and L-histidine · HCl · H_2O crystals. In these three crystals we have identified three main species, which, depending on the molecular environment, were stabilized at different temperatures and produced in different concentrations. These findings are discussed in connection with the observations made on irradiated aqueous solutions of amino acids. It was concluded that our results corroborate the mechanism for the action of ionizing radiation on dry protein proposed by Platzman and Franck (1958, Symposium on Information Theory in Biology, (New York; Pergamon Press), p. 252). (auth)

3663 GAMMA-RAY-INDUCED THYMINE DAMAGE IN THE DNA IN COLIPHAGE ϕ×174 AND IN E. COLI. Swinehart, J. L.; Cerutti, P. A. (Univ. of Florida, Gainesville). Int. J. Radiat. Biol.; 27: No. 1, 83-94(Jan 1975).

The radiation chemical reactivity of thymine residues has been compared for single-stranded ϕX174 DNA free in solution and in the intact bacteriophage, as well as for native E. coli DNA in solution and inside the cell. The γ-ray-induced release of [^{3}H] H_2O from thymine-methyl[^{3}H] was measured to assess the reactivity of the thymine methyl group. Formation of ring-saturated products of the 5,6-dihydroxy-dihydrothymine type [t'] was determined by an alkali-acid degradation assay. It was observed that the formation of [^{3}H] H_2O was suppressed by a factor of 9 in intact ϕX174 bacteriophage compared to ϕX174 DNA, whereas the formation of t' was only slightly suppressed in the phage. For E. coli cells the formation of [^{3}H] H_2O was reduced 790-fold compared with free E. coli DNA, and t' formation was reduced 140-fold. The extents of survival after γ irradiation of ϕX174 phage plaque-forming ability and E. coli colony-forming ability were also determined. Under the conditions used in these experiments, a linear relationship was observed between the loss of biological activity and the formation of thymine damage for both ϕX174 phage and E. coli cells. (auth)

3664 FREE RADICAL FORMATION IN PYRIMIDINE DERIVATIVES: A STUDY OF 5-NITROURACIL AT 77 K. Bergene, R.; Evensen, J.; Henriksen, T. (Univ. of Oslo). Radiat. Res.; 62: No. 2, 180-194(May 1975).

The ESR spectra of 5-nitrouracil, irradiated at 77°K, yield evidence for the formation of several radical species. The two radicals that exhibit the strongest ESR signals are discussed. One of the resonances consists of a three line pattern with an isotropic splitting constant of 56.5 G and an average g-factor of 2.0007. These data are compatible with the interpretation that the NO_2 group is abstracted from the pyrimidine ring and trapped within the crystal lattice. The principal tensor values suggest that the oxygen atoms are kept at their original positions and that the nitrogen atom swings out of the pyrimidine plane. Furthermore, the data indicate some molecular motion around the O–O direction. The other resonance consists of a triplet of doublets due to hyperfine

interactions with a nitrogen and a proton in a nitrogen centered pi-radical. In an attempt to identify the responsible radical, extensive INDO-MO calculations were performed. The bulk of data support the hypothesis that a deprotonated radical anion is responsible for the resonance. (auth)

3665 NUCLEOLYTIC DEGRADATION OF HOMOLOGOUS AND HETEROLOGOUS DEOXYRIBONUCLEIC ACID MOLECULES AT THE SURFACE OF COMPETENT PNEUMOCOCCI. Seto, H.; Lopez, R.; Garrigan, O.; Tomasz, A. (Rockefeller Univ., New York). J. Bacteriol.; 122: No. 2, 676-685(May 1975).

Competent pneumococci can catalyze the rapid and quantitative degradation of extracellular deoxyribonucleic acid (DNA) molecules through the activity of surface-located nucleases (endo- and, possibly, exonucleases as well). Both homologous and heterologous DNAs are degraded by a mechanism that seems to involve a cyclic process: attachment of DNA to the cell surface followed by (ii) nucleolytic attack, and (iii) release to the medium. Processes (ii) and (iii) are both inhibited by ethylenediaminetetraacetate. Whereas surface nuclease activity is specific for competent cells, the bulk of this activity is not coupled to irreversible DNA uptake (deoxyribonuclease-resistant binding). Pneumococcal DNA treated with ultraviolet irradiation or nitrous acid (cross-linking) is selectively impaired in the ability to irreversibly bind to competent cells, whereas reversible binding is normal. (auth)

Radiation Effects on Cells

3666 (COO-3110-17) CELLULAR HEREDITY IN HAPLOID CULTURES OF SOMATIC CELLS. Annual Progress Report, March 1, 1974–March 31, 1975. Freed, J. J. (Institute for Cancer Research, Philadelphia, Pa. (USA)). 1975. Contract AT(11-1)-3110. 14p. Dep. NTIS $4.00.

Brief accounts are presented of research with haploid cultured frog cells. Studies of ultraviolet radiation effects on cultured frog cells that are fundamental to the more effective use of this agent as a mutagen are discussed. (CH)

3667 (ORO-2832-147) RADIATION AND BIOPHYSICAL STUDIES ON CELLS AND VIRUSES. Progress Report, February 29, 1974–March 31, 1975. Cole, A. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex. (USA)). [nd]. Contract AT(40-1)-2882. 45p. Dep. NTIS $5.50

Progress is reported on the following research projects: sedimentation analysis of chromosome components from interphase and mitotic chromosomes; electron microscopy of mitotic chromosomes; radiosensitive site analysis using short range particle beams; studies on nucleoproteins and DNA; RBE and OER for double strand breaks and single strand breaks of DNA irradiated with ^{241}Am alpha particles; use of ^{241}Am alpha particle track-ends to study the location of radiosensitive sites; gamma irradiation of nucleoprotein model systems; assembly of new equipment for the analysis of DNA size distributions; cell rejoining of DNA breaks induced by various radiation; studies on cell transformation induced by gamma radiation; localization of cellular sites for DNA breakage using labeled specific antibodies; and semiconductor properties of melanins related to preferential killing of melanoma cells. (HLW)

3668 MODIFICATION OF THE RADIATION RESPONSE OF AN IN VITRO TUMOUR MODEL BY CONTROL OF CELLULAR RESPIRATION. Durand, R. E.; Biaglow, J. E. (Univ. of Wisconsin, Madison). Int. J. Radiat. Biol.; 26: No. 6, 597-601(Dec 1974).

The role of cellular respiration rate in the radiation response of multicellular spheroid systems in vitro, was investigated using an uncoupler of oxidative phosphorylation, 2,4-dinitrophenol (DNP). This drug has a biphasic effect on mitochondrial utilization of oxygen, stimulating at low concentrations (0.8 to 1.33 mM) and inhibiting at high concentrations (> 1.7 mM). The results demonstrated that altering the utilization of oxygen by the outer cells of a multicellular spheroid produced dramatic changes in cell-killing by radiation. At the higher concentrations, the observed long equilibration time (1 to 1½ hours after DNP addition) for maximum radiosensitivity suggested either that the effective rate of DNP diffusion was very low, or else that the oxygen consumption of the intermediate cells was temporarily increased, providing an additional barrier to the diffusion of oxygen to the hypoxic centers. The equilibration time was shorter (45 min) for maximum radioresistance at the lower concentrations, presumably since the cells closer to the spheroid surface were the ones most affected by the increased oxygen utilization of the exterior cells. This observed increased oxygen consumption at low DNP concentrations appeared to result from classical uncoupling of cellular oxidation from phosphorylation. The results suggest that respiratory inhibitors should be beneficial in radiotherapy even if they only reach the oxygenated portion of the tumor, in contrast to hypoxic sensitizers which must reach parts of a tumor which are remote from the blood supply. (UK)

3669 X-RAY DOSE RESPONSE FOR MUTATION TO FRUCTOSE UTILIZATION IN CULTURED DIPLOID HUMAN FIBROBLASTS. Cox, R.; Masson, W. K. (Medical Research Council, Harwell, Eng.). Nature (London); 252: No. 5481, 308-310(22 Nov 1974).

Some studies are reported using fructose, in place of glucose, as the major carbon and energy source in x-ray mutation investigations in a culture of diploid human fibroblasts. (UK)

3670 EFFECT OF SPLIT DOSES OF X RAYS ON NEOPLASTIC TRANSFORMATION OF SINGLE CELLS. Borek, C.; Hall, E. J. (Columbia Univ., New York). Nature (London); 252: No. 5483, 499-501(6 Dec 1974).

Using cloned hamster embryo cells in culture it was found that if an x-ray dose is divided into two fractions, more neoplastic transformations occur than if the same dose is given in a single exposure. This could have important implications in radiation protection, where in general radiation is accumulated in a number of small fractions rather than in a single large exposure. (auth)

3671 RADIOSENSITIZING AND RADIOPROTECTIVE EFFECT OF THE ORGANIC NITROXYL-FREE RADICAL TMPN ON EXTREMELY HYPOXIC HUMAN CELLS OF LINE NHIK 3025, CULTIVATED IN VITRO. Pettersen, E. O.; Oftebro, R.; Brustad, T. (Norsk Hydros Institutt for Kreftforskning, Oslo). Int. J. Radiat. Biol.; 26: No. 6, 523-534(Dec 1974).

Human cells from the established line NHIK 3025 have been irradiated in suspension under extremely hypoxic conditions (< 4 p.p.m. O_2) and in presence of the organic nitroxyl-free radical TMPN (2,2,6,6, tetramethyl-4-piperidinol-N-oxyl), at four concentrations, viz. 0.5 mM, 1 mM, 3 mM, and 10 mM. TMPN was found to exhibit both a sensitizing and a protective effect. The sensitizing effect appeared at high doses (> 400 to 800 rads, dependent on TMPN-concentration) and increased with increasing TMPN concentrations. At low doses (< 400 to 800 rads) TMPN was found to exert a protective effect. Below 300 rads, the protection was found to be optimal for a TMPN-concentration between 0.5 and 3 p.p.m. Within the concentration limits here studied it was found that the dose-range in which TMPN exerts a protection increased with decreasing TMPN-concentration. The slope of the survival curves was found to increase when the dose exceeded about 2000 rads, irrespective of whether the cells were in contact with 1 mM, 0.5 mM, or no TMPN. This suggested that TMPN did not affect the dose-level at which the medium effect appeared. (Pettersen, Oftebro and Brustad, 1974, Int. J. Radiat. Biol., 26, 305). (auth)

3672 EFFECTS OF RADIATION ON CULTURED BHK CELLS AND THEIR LATENT "R" PARTICLES. An Electron Microscope Study. Conti, C. J.; Klein-Szanto, A. J. P.; Moreira, J. L. (CNEN, Buenos Aires). Arch. Geschwulstforsch.; 43: No. 3, 254-267(1974).

BHK 21 cl 13 cells were x-irradiated, (200 kV) with 5000 rads. Ultrastructural alterations in their morphology were studied up to the 4th post-irradiation day. Important fine structural changes were found in the nuclei and in the cytoplasm of the irradiated cultured cells, especially in the endoplasmic reticulum and the cytoplasmic processes. Numerous nuclear inclusions of the filamentous type, nuclear pseudoinclusions, and nuclear membrane alterations were observed from the 2nd post-irradiation day on. The occurrence of several cisternal dilations of the ER was a frequent finding. Lipid droplets, lysosomes, and roundish swollen cellular processes we also noted in the irradiated cells. A very interesting feature of irradiated cells has been the presence of numerous virus-like "R" particles. They were usually seen in the endoplasmic reticulum presenting the spherical, filamentous, or budding types. It is concluded that, in spite of the important radiation-produced cellular alterations, "R" particles remained relatively undamaged, maintaining their multiplication capacity within the lethally injured BHK cells. (auth)

3673 INTERACTION OF γ-RAY AND NEUTRON EFFECTS ON THE PROLIFERATIVE CAPACITY OF CHINESE HAMSTER CELLS. Railton, R.; Lawson, R. C.; Porter, D. (Western Regional Hospital Board, Glasgow). Int. J. Radiat. Biol.; 27: No. 1, 75-82(Jan 1975).

The loss of reproductive capacity of Chinese hamster cells was studied using ^{60}Co γ rays and DT neutrons singly or combined in fixed proportions. Surviving fractions were measured down to 2×10^{-4}. Interaction between the effects produced by neutrons and γ rays in the mixed irradiations was demonstrated. The results are compared with those predicted by the cellular inactivation model developed by Katz and co-workers from their delta-ray theory of track structure. (auth)

3674 DNA-TO-PROTEIN CROSS-LINKING SYNCHRONIZED HeLa CELLS EXPOSED TO ULTRA-VIOLET LIGHT. Han, A.; Korbelik, M.; Ban, J. (Sredisnji Institut za Tumore i Slicne Bolesti, Zagreb). Int. J. Radiat. Biol.; 27: No. 1, 63-74(Jan 1975).

The uv-induced DNA-to-protein cross-linking in synchronously growing HeLa cells exhibited age-dependent variations. The maximum yield of cross-linking was observed during S-phase and exposure of mid-S cells to 250 ergs/mm^2 rendered about 22% of DNA unextractable owing to cross-linking with proteins. Cells irradiated in G_1 or G_2 exhibited much smaller amount of cross-linking. The unextracted DNA was recovered from the protein fraction, and the addition of 0.5% trypsin solution rendered all the DNA extractable. Fluctuations in the age-response pattern for the yield of DNA-protein cross-links varied throughout the cell-cycle in the same way as the efficiency for cell-killing, i.e., cells were resistant in G_1, sensitive as they moved into and through the S phase, and resistant again in G_2. Dose-response curves determined at different times in the cycle revealed that up to about 500 ergs/mm^2 the amount of DNA recovered from S cells decreased by about 8% for every 100 ergs/mm^2 of uv light. The amount of recovered DNA remained unchanged for cells exposed to 500 ergs/mm^2 in the middle of S, for as long as 8 hours after exposure, i.e., for as long as the experiments were carried out no recovery from this damage was observed. (auth)

3675 MODELS FOR CELL SURVIVAL WITH LOW LET RADIATION. Payne, M. G.; Garrett, W. R. (Oak Ridge National Lab., TN). Radiat. Res.; 62: No. 2, 169-179(May 1975).

A model for cell survival under low LET irradiation was developed in which the cell is considered to have N_0-independent sensitive sites, each of which can exist in either an undamaged state (state A) or one of two damaged states. Radiation can change the sensitive sites from the undamaged state to either of two damaged states. The first damaged state (state B) can either be repaired or be promoted on the second damaged state (state C), which is irreparable. The promotion from the first damaged state to the second can occur due to any of the following: (1) further radiation damage, (2) an abortive attempt to repair the site, or (3) the arrival at a part of the cell cycle where the damage is "fixed." Subject to the further assumptions that radiation damage can occur either indirectly (i.e., through radiation products) or due to direct interaction, and that repair of the first damaged state is a one-step process, expressions can be derived for P(N/sub A/, N/sub B/,t) equals probability that after time t a cell will have N/sub A/ sites in state A and N/sub B/ in state B. The problem of determining P(N/sub A/, N/sub B/, t) is formulated for arbitrary time dependences of the radiation field and of all rate coefficients. A large family of cell-survival models can be described by interpreting the sensitive sites in different ways and by making different choices of rate coefficients and of the combinations of numbers of sites in different states that will lead to cell death. (auth)

3676 DNA DAMAGE FROM INCORPORATED RADIOISOTOPES: INFLUENCE OF THE ^{3}H LOCATION IN THE CELL. Burki, H. J.; Bunker, S.; Ritter, M.; Cleaver, J. E. (Univ. of California, Berkeley). Radiat. Res.; 62: No. 2, 299-312(May 1975).

DNA single-strand-breakage efficiency was measured in frozen Chinese hamster cells (V79-S171) after they accumulated disintegrations from incorporated tritium. The results are compared to the single-strand-breakage efficiency of x rays at dry ice or liquid nitrogen temperatures, which is reduced by a factor of 4 from the strand-breakage efficiency found at 37^{0}C. Tritium decays in cells that incorporated [5-^{3}H]uridine into RNA after a 30-min pulse were 20 percent as effective as those in [^{3}H]thymidine-labeled cells in causing single-strand breaks in DNA. This difference in DNA strand-breakage efficiencies for [^{3}H]uridine and [^{3}H]thymidine is almost the same as the difference in efficiencies of cell killing from the two macromolecular locations of tritium within the nucleus of the cell. In cells labeled in one or both strands of DNA with [^{3}H]thymidine the breakage efficiencies were 2.2 to 2.3 breaks per ^{3}H decay, equivalent to 0.5 rads per decay--a value very close to that predicted for the dosimetry of ^{3}H beta particles. Irradiation by ^{3}H decays from tritiated water added to the medium before freezing was intermediate between [^{3}H] uridine and [^{3}H]thymidine in producing single-strand breaks. Isolation of ^{3}H-labeled DNA and freezing in solution at a concentration less than that found in the cell nucleus produced a lower strand-breakage efficiency because of a reduction in the dose to the DNA by the short-ranged beta particles. (auth)

3677 RELATIONSHIP BETWEEN LOSS OF NEGATIVE CHARGE ON NUCLEAR MEMBRANE AND LOSS OF COLONY-FORMING ABILITY IN X-IRRADIATED CELLS. Sato, C.; Kojima, K.; Matsuzawa, T.; Hinuma, Y. (Aichi Cancer Center Research Inst., Chikusa-ku, Japan). Radiat. Res.; 62: No. 2, 250-257(May 1975).

Alterations in the negative charge of isolated nuclei after x irradiation were investigated by electrophoresis in three different radiosensitive cell lines. The electrophoretic mobility decreased with time after irradiation and reached a minimum 4 hr after exposure. The relationship between the decrease in mobility measured 4 hr after irradiation and the radiation dose was linear and independent of cell lines utilized. In Burkitt lymphoma cells P3HR-1 (n equals 1, D_0 equals 67 R) the decrease in mobility was irreversible: The surviving fraction of cells (colony-forming ability) and the fraction of electrophoretically intact nuclei 4 hr after exposure showed good correlation. In mouse melanoma cells B16-C2W (n equals 20, D_0 equals 160 R), however, the nuclear charge recovered almost completely by 24 hr after irradiation with doses up to 500 R, and good correlation was indicated between the surviving fraction (colony-forming ability) and the fractions of "electrophoretically intact" nuclei isolated 24 hr after exposure for five dose-points. (auth)

3678 RESTRICTED GROWTH OF HUMAN CYTOMEGALOVIRUS IN UV-IRRADIATED WI-38 HUMAN FIBROBLASTS. Furukawa, T.; Tanaka, S.; Plotkin, S. A. (Wistar Inst. of Anatomy and Biology, Philadelphia). Proc. Soc. Exp. Biol. Med.; 148: No. 4, 1249-1251(Apr 1975).

The growth of human CMV was inhibited by uv irradiation of cells prior to infection or during the 48-hr latent period of virus replication but not after virus synthesis began. The duration of uv exposure sufficient to inhibit CMV replication was insufficient to inhibit replication of Herpes simplex and did not prevent uninfected cells from dividing normally. The effect of uv irradiation on CMV replication may have been mediated through prevention of the stimulating effect of the virus on host cell RNA(s) synthesis. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 3068, 3663, 3665, 3667, 3804, 5802, 5805, and 5812.

3679 PHOTOREACTIVATION OF THYMINE-STARVED ESCHERICHIA COLI B_{s-1}. Gosh, N.; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Photochem. Photobiol.; 21: No. 1, 1-4(Jan 1975).

Thymine starvation prior to 254 nm ultraviolet light (uv) exposures has been found to decrease the level of maximum photoreactivation in Escherichia coli B_{s-1}. The dark equilibrium level of photoreactivating enzyme-substrate complexes was determined from the levels of photoreactivation obtained with exposures to single flashes of high-intensity light. The kinetics indicated that photoreactivating enzyme concentration did not decrease as a result of thymine starvation. The uv sensitivities of normal and thymine-starved cells were found to be the same. Photoreactivation by sequential flashes showed a lesser number of total photorepairable lesions in starved cells. It was concluded that thymine starvation rendered a portion of the dimers inaccessible to the photoreactivating enzyme, thus lowering the level of maximum photoreactivation. (auth)

3680 METRONIDAZOLE ("FLAGYL"): MECHANISMS OF RADIOSENSITIZATION. Willson, R. L.; Cramp, W. A.; Ings, R. M. J. (Brunel Univ., Uxbridge, Eng.). Int. J. Radiat. Biol.; 26: No. 6, 557-569(Dec 1974).

Radiation biochemical and bacterial studies were undertaken to investigate possible mechanisms of radiosensitization by metronidazole. It was concluded that the nitro-group plays a major role in its action and that at least four mechanisms may be operative under hypoxic conditions: enzyme-catalyzed depletion of nucleophiles, fixation of organic radicals, interference with recombination reactions, and formation of toxic products. (auth)

3681 GENETIC CONTROL OF RADIATION SENSITIVITY IN SCHIZOSACCHAROMYCES POMBE. Nasim, A. (National Research Council, Ottawa); Smith, B. P. Genetics; 79: No. 4, 574-582(Apr 1975).

Genetic analysis of a large number of radiation-sensitive mutants of S. pombe, isolated in different laboratories, showed that these isolates represent 22 non-allelic loci. The mutants were shown to fall into three distinct classes concerning response to uv and ionizing radiation, including two mutants which are primarily sensitive to ionizing radiation but not to uv. Single-gene mutants were crossed to obtain supersensitive double mutants. Such double mutants showed a marked increase in sensitivity to a variety of inactivating agents as compared to the parental strains. The isolation of three classes of radiation-sensitive mutants and the construction of double mutants implies the presence of multiple pathways in S. pombe for repair of radiation-induced damage. The

bearing of these data on cellular repair mechanisms in eukaryotes is discussed. (auth)

3682 LOCATION OF THE ESCHERICHIA COLI K-12 RUV GENE AFFECTING SEPTUM FORMATION AFTER INHIBITION OF DEOXYRIBONUCLEIC ACID SYNTHESIS. Iyehara, H.; Otsuji, N. (Kyushu Univ., Higashi-ku, Japan). J. Bacteriol.; 122: No. 2, 791-793(May 1975).

Escherichia coli ruv gene was located at 36.1 min on the chromosome by P1 transduction experiments and the gene order his - supD - uvrC, dar4 - ruv - eda -fadD - pps was proposed. Complementation analysis by an F' factor carrying genes in the his region indicated that ultraviolet light sensitivity genes, ruv and uvrC, consist of different cistrons and wild-type alleles of these genes are dominant over the mutant alleles. (auth)

3683 RELATIONSHIP BETWEEN STRUCTURE AND FUNCTION IN THE RADIATION INJURIES OF T7 PHAGES. Ronto, G.; Tarjan, I. (Semmelweis Medical Univ., Budapest). Acta Biochim. Biophys. Acad. Sci. Hung.; 7: No. 3, 251-254(1972).

The authors analyzed the radiation injury process from the absorption of the uv photon until the biological manifestation of radiation injury. For the analysis the results of their earlier kinetic model on the radiation injury of T7 phages and the data in the literature on the molecular properties of T7 phages are used. By the analysis they conclude that the injurable places assumed in the model are the cytosine clusters of T7-DNA which are functionally the initial and the terminal sites of the transcription, respectively. The one hit kinetics is based on the information content of T7 phages concerning non-lysogene functions. (auth)

3684 STUDY OF THE UV EFFECT ON MS2 PHAGES. Karczag, A.; Ronto, G.; Tarjan, I. (Semmelweis Medical Univ., Budapest). Acta Biochim. Biophys. Acad. Sci. Hung.; 7: No. 2, 173-177(1972).

The effect of $\lambda = 254$ nm uv light on the plaque forming activity of MS2 phages has been examined. It has been established that the dose-effect curve similar to that of the T7 phages is of the one hit type and, when seen from above, its shape is concave. An attempt was made to analyze the dose-effect curve with our radiation kinetic model developed for the T7 phages. The deviation of the dose-effect curve from that of the T7 phages was assumed to be brought about by the induction of different photoproducts of the DNA and RNA bases: upon the effect of uv irradiation uracil may undergo, besides dimerization, hydration, too. From the initial phase of the MS2 dose-effect curve and from the comparison of the T7 and MS2 dose-effect curves the probability of phage inactivation due to dimer formation and to hydration has been determined and found to be about $2 \cdot 10^{-4}$ and $1 \cdot 10^{-4}$, respectively. The former value is similar to the probability obtained for T7 phages. (auth)

3685 DECREASE IN SENSITIVITY OF CELLS AFTER SPLIT-DOSE RECOVERY. Evidence for the Involvement of Protein Synthesis. Bryant, P. E. (Medical Research Council, London). Int. J. Radiat. Biol.; 27: No. 1, 95-102(Jan 1975).

The effect of protein synthesis inhibition on the response of Chlamydomonas reinhardii to single and split doses of x rays has been investigated. Chloramphenicol (100 μg/ml) together with cycloheximide (10 μg/ml) completely inhibited protein synthesis in unirradiated cells, without diminution of plating efficiency over periods of up to 6 hours. The synthesis of protein in the control suspension, as measured by the uptake of ^{3}H-L-leucine, took place without apparent delay in the absence of the drugs. Studies were made of survival curves for cells irradiated with single or split doses of x rays, with and without drug treatment at various times relative to exposure. Results for single doses, where cells were given protein-synthesis inhibitors during and after irradiation demonstrated little change in the shape of the survival curve. When drugs were given as a pre-irradiation treatment, the main effect seemed to be on the shoulder width of the survival curve. The increased value of D_0 of the survival curve for cells given split doses failed to appear when the growth medium in which the cells were held between doses contained the drugs, giving support for the hypothesis that the increased capacity for repair of potentially lethal damage after the second x-ray exposure resulted from de novo enzyme synthesis induced by radiation. (UK)

3686 ROLE OF DNA SEQUENCES IN GENETIC RECOMBINATION IN THE iso-1-CYTOCHROME C GENE OF YEAST. I. Discrepancies Between Physical Distances and Genetic Distances Determined by Five Mapping Procedures. Moore, C. W.; Sherman, F. (Univ. of Rochester, NY). Genetics; 79: No. 3, 397-418(Mar 1975).

Recombination rates have been examined in two-point crosses of various defined cyc1 mutants using five mapping methods. Nucleotide sequences of mutant codons were identified in previous studies from alterations in functional iso-1-cytochromes c produced by intragenic revertants. Heteroallelic diploids were analyzed for rates of mitotic recombination that occurred spontaneously and that were induced with x rays, ultraviolet light and the near-ultraviolet light emitted by sunlamps, as well as rates of meiotic recombination that occur after sporulation. Frequencies of both mitotic and meiotic recombination do not necessarily correspond with physical distances separating altered nucleotides. The most extreme discrepancy involved two adjacent intervals of thirteen base pairs which differed approximately thirtyfold in their spontaneous and x-ray-induced recombination rates. Marked disproportions between genetic and physical distances appear to be due to the interaction of the two nucleotide sequences in the heteroallelic combination and not to the sequences of the mutant codons alone. Recombination values that were obtained by all five methods could not be used to establish the correct order of mutant sites. Relationships of the recombination rates for the various pairwise crosses are different after mitosis from those after meiosis, suggesting that these two recombinational processes are to some extent different in their dependence on particular nucleotide configurations. On the other hand, the relationships of the rates induced by uv, sunlamp- and x-irradiation were identical or very similar. In addition to the intrinsic properties of the alleles affecting frequencies of mitotic and meiotic recombination rates, two- to threefold variations in recombination rates could be attributed to genetic backgrounds. (auth)

3687 MUTAGENESIS BY ULTRAVIOLET RADIATION IN BACTERIOPHAGE PHIX174. On the Mutation Stimulating Processes Induced by Ultraviolet Radiation in the Host Bacterium. Bleichrodt, J. F.; Verheij, W. S. D. (Rijksverdedigingsorganisatie TNO, Rijswijk (Netherlands). Medisch Biologisch Lab. TNO). Mol. Gen. Genet.; 135: No. 1, 19-27(Dec 1974).

The fraction of mutants measured in a population of ultraviolet (uv)-irradiated bacteriophage ϕX174 is higher when the mutants are assayed on host cells irradiated with a small dose of uv than when unirradiated cells are used for assay. Evidence is presented that the uv-induced processes in the bacteria which are responsible for the increased number of mutants introduce mutations prior to the replication of the double-stranded replicative form DNA to which the parental single-stranded ϕX174 DNA is converted after infecting the host cell. These processes also result in an enhanced fraction of spontaneous mutants in unirradiated populations of ϕX174. Furthermore, it is shown that the spectrum of mutants in unirradiated as well as in irradiated ϕX174 differs for assay of mutants on unirradiated and uv-irradiated bacteria. The transition A → G is observed less frequently when the phage is assayed on irradiated cells. Neither uv-induced nor spontaneous mutation frequencies were enhanced when the uv-irradiated host bacterium carried a recA mutation. (auth)

3688 EFFECT OF DIFFERENT uv RADIATION DOSES ON PIGMENTARY AND NONPIGMENTARY YEASTS. Anzhelova-Patarinska, Z.; Solakova, I. M. (Bylgarska Akademiya na Naukite, Sofia. Inst. po Promishlena Mikrobiologiya). Compt. Rend. Acad. Bulg. Sci.; 27: No. 4, 543-546(1974).

The reaction of yeast cells to uv radiation depending on the presence or absence of carotinoid pigments was investigated. The reaction was substantially affected by the presence or absence of carotinoid pigments. With low radiation dose of the order of $1.56\ 10^4$ erg/cm^2, uv light produces a stimulating action of both strains. With higher radiation doses ($18\ 10^4$ erg/cm^2) the carotinoid pigments produce a protective action. Only the pigmentary strain survives and shows growth. Intensified biosynthesis of carotinoid pigments under the action of radiation has also been established, which is in connection with certain changes in the metabolism in the yeast cell. (INIS)

3689 IMMUNIZATION TRIALS WITH GUINEA PIGS AND LAMBS USING D. FILARIA LARVAE IRRADIATED WITH GAMMA RAYS. Denev, J. Vet. Med. Nauki (Sofia); 11: No. 9, 7-12(1974). (In Bulgarian).

A total of 24 guinea pigs and 26 lambs were used to test the effect of gamma rays on D. filaria larvae. The guinea pigs were given 1000 infective larvae each, irradiated with 10, 20, and 40 kR and the lambs were given 5000 infective larvae each, treated with 40 kR. It was found that larvae treated with 40 kR induce immunologic reconstruction in the organism and may be used as vaccines. The number of adult parasites found in the test lambs was 10 to 23 times lower than their number in the control animals; the female to male helminths ratio were 4:1 (test animals) and 1:1 (controls). A single dose of 5000 irradiated D. filaria larvae confers immunity for about 60 to 65 days; after reinfection immunity is prolonged for some more 65 days. The morphologic lesions

in the test lambs are comparatively more slightly manifested as compared with the controls. (auth)

Radiation Effects on Plants

Refer also to abstracts 3661, 3757, 3759, 5791, and 5813.

3690 (KFK-tr-445) ASSESSMENT OF THE WHOLESOMENESS OF A DIET WITH PREDOMINANT CONTENT OF γ-IRRADIATED PLANT PRODUCTS. Bronnikova, I. A.; Okuneva, L. A. Translated from Vop. Pitan.; 31: No. 4, 74-80(May 1974). 12p. (In German). INIS.

The results of three-year investigations on a diet that contained all permitted γ-irradiated plant products are given. Long-term biological experiments by feeding a test diet to five generations of rats were carried out. The results show that the administration of a diet that contained 82.2 to 83.6% γ-irradiated products, according to the calorific value, for improvement of its preservation had no unfavourable influence on animals. According to the results of the dominant lethal test, no mutagenic effect of the irradiated plant products could be detected. (GE)

3691 CHIMERISM OF GENERATIVE TISSUE OF ARABIDOPSIS THALIANA INDUCED BY GAMMA IRRADIATION OF SPROUTS. Shevchenko, V. V.; Grinikh, L. I.; Grigorieva, G. A.; Draginskaya, L. Ya. (Inst. of Developmental Biology, Moscow). Genetika; 11: No. 2, 69-72(Feb 1975). (In Russian).

Sprouts of Arabidopsis thaliana were exposed to gamma rays (at doses of 1, 3, 5, and 10 kR) at the stage of the first pair of leaves. The score of chlorophyll-deficiency mutations was made according to Muller embryo-test. The mutations observed in different inflorescences of the same plant proved to be identical, thus suggesting the formation of generative tissue of all inflorescences by the same group of initial cells. Mutant pods (20.8%) were observed in the main inflorescences, 21.0%—in the side inflorescences developed from axils of cauline leaves, and 12.4% in the side inflorescences developed from the axis of rozette leaves. Therefore at the moment of irradiation there was a small number of initial cells (about five to eight) which gave rise to the generative tissue. (auth)

3692 POSSIBILITIES OF OBTAINING HIGH-LYSINE MAIZE THROUGH GAMMA-RAY TREATMENT. Popova, J. Mezhdunar. Sel'skokhoz. Zh.; 17: No. 3, 64-65(1973). (In Bulgarian).

Treated dry seeds of the self-pollinated No. 38-11 maize line in M_2 with 6 krad gamma rays of a ^{60}Co source gave rise to a high-lysine mutant, from which the FM-829-5 line was developed containing 0.807% lysine on the basis of absolute dry substance and on a three year mean. This content surpassed that of the American A Opaque-2 synthetic. It is recommended for initial material in maize breeding. (auth)

3693 MAJOR COMPONENT OF THE RADIATION EFFECT. Interference with Endocellular Control of Cell Proliferation and Differentiation. Wangeheim, K. H. V. (Kernforschungsanlage, Juelich GmbH, Ger.). Int. J. Radiat. Biol.; 27: No. 1, 7-30(Jan 1975).

Cytological investigations with diploid and autotetraploid plant materials revealed that cytoplasmic growth, including the propagation of autoreduplicating cytoplasmic units such as mitochondria and proplastids, continued during the radiation-induced mitotic delay, thus increasing the ratio of cytoplasmic amount: nuclear ploidy. In accordance with a control mechanism, detected in the plant endosperm, this increase caused mitotic inhibition due to an early induction of otherwise normal differentiation processes. Although mutations are not a prerequisite, they can act in an auxiliary manner by quantitative action. The contribution of early differentiation to non-survival varied according to irradiation conditions and could outweigh the direct effects of irreversible genetic damage. Therefore, a higher level of ploidy could not improve survival significantly, if mitotically-active tissues were irradiated under the usual conditions. Corresponding observations are known from animals. The results suggested that the control mechanism of the endosperm was general to multicellular organisms, and could be modulated by extracellular agents. (auth)

3694 EFFECT OF PRE-PLANTING IRRADIATION OF SEEDS ON THE SUGAR BEET YIELD. Fedin, P.; Popov, I. (Akademiya na Selskostopanskite Nauki, Sofia (Bulgaria). Inst. po Genetika). Rast. Nauki; 11: No. 5, 32-37(1974). (In Bulgarian).

Pre-planting seed treatment with gamma rays as affecting both beet yield and sugar content was studied. Air dried germinative seeds of the Beta poly 3 and Yaltoush monogerm varieties were irradiated with gamma rays in total doses of 1000 to 4000 R. After treatment, the seeds were planted in a check board trial with six replications. Results show that pre-planting irradiation of seed with stimulating doses of gamma rays does not substantially affect the sugar output. Differences in yields of untreated and treated plants are mathematically not proven. One and the same dose of rays produces a different effect in the separate years which is dependent on the conditions of irradiation and plant growing. Variable results of pre-planting seed irradiation make this method unsuitable to the sum total of all external conditions beyond a control. (auth)

3695 POSSIBILITIES OF DEVELOPING INITIAL BREEDING MATERIAL OF PEANUT (ARACHIS HYPOGAEA L.) BY IRRADIATION. Popov, P.; Dimitrov, J.; Georgiev, S. Genet. Selek.; 7: No. 2, 157-164(1974). (In Bulgarian).

After irradiation of seeds of two varieties with ^{60}Co gamma rays during 1969 to 1971, the M_1, M_2, and M_3 generations were studied. The varieties of the Valencia type differ in their reaction to irradiation at a dose of 18 krad. Only 11.8% of the plants of the Velikan variety survived and produced seeds, while for the variety Sadovski Podobreni this percentage was 2.2. The M_2 and M_3 plants revealed great diversity concerning both plant morphology and economical characters useful for breeding purposes: earliness productivity, seed output, pod and seed size, compact and erect plant growth with compact pod arrangement. The changes in these characters were more pronounced in the hybrid Velikan than in Sadovski Podobreni. The uniformity of the material and the stabilization of the most part of progenies in peanuts are almost completed in the M_3 generation. This permits to decrease sharply the duration of the breeding process. Irradiation of the seeds with ^{60}Co gamma rays at 18 krad appears to be a promising breeding method for developing rich initial breeding material. (auth)

3696 PRE-PLANTING RADIATION OF TULIP BULBS AS DETERMINING THEIR PROPAGATION ABILITY. Doncheva, A. Gradinar. Lozar. Nauka.; 11: No. 3, 129-136(1974). (In Bulgarian).

In tests aimed at determination of the propagation coefficient, the bulbs of the Lefeberg's Favourite tulip cultivar were x-ray treated. Bulbs of the following sizes were experimented: (1) diameter of over 4 cm or circumference over 12 cm; (2) diameter 3 to 4 cm, circumference 11 to 12 cm; (3) diameter 2 to 3 cm, circumference 9 to 11 cm, and (4) diameter 1.5 to 2.0 cm, circumference 7.4 cm. Bulbs of (1) proved most productive, followed by the remaining groups in the order given above. This dependence remains at x-ray treatments. Doses of 200, 300, and 400 rad raise the amount of bulbs. Higher doses produce elongated bulbs of smaller size. The experimented x-ray doses provoke chromosomal aberrations and therefore, the appearance of more valuable tulip forms is possible. (auth)

3697 INFLUENCE OF DIFFERENT DOSES OF GAMMA RAYS ON CERTAIN TISSUES OF PEA PLANTS. Izvorska, N. D. (Bylgarska Akademiya na Naukite, Sofia. Inst. po Fiziologiya na Rasteniyata). Compt. Rend. Acad. Bulg. Sci.; 27: No. 3, 399-402 (1974).

Using the method of isolated cultures, the reaction to different doses of gamma rays by certain differentiated tissues and organs of pea plants was studied. It was established that the growth of the callus tissues depends on the doses of gamma rays applied: doses that inhibit the growth of the fresh biomass raise the accumulation of a greater amount of dry matter in the callus tissues, whereas the doses stimulating the growth of the irradiated calluses generally inhibit the accumulation of dry matter. The cytological observations showed that the size and the number of cells from the irradiated calluses is also influenced by the doses of gamma rays applied. The callus tissues obtained from roots, stems, and leaves react differently to irradiation. Most sensitive to radiation are the calluses obtained from roots and leaves which react more strongly both to stimulating and to the inhibiting doses of gamma rays, compared with the calluses from stems. (INIS)

Radiation Effects on Animals

Refer also to abstract 5793.

Man

Refer also to abstract 3063.

3698 (AED-CONF-74-509-041) CLINICAL DOSIMETRY OF CALIFORNIUM-252. Nagarajan, P. S.; Iyer, P. S. (Bhabha Atomic Research Centre, Bombay (India)). 1974. 6p. INIS.

From symposium on neutron dosimetry in biology and medicine; Neuherberg/Muenchen, F. R. Germany (30 Sep 1974).

3 figs.; 3 tabs.; 19 refs. With abstract. Available from ZAED.

Californium-252, a source of fission neutrons, is being investigated as a potential replacement of radium and other gamma emitters in radiation therapy. The advantages of the source include favourable oxygen enhancement ratio, absence of gaseous radioactive daughter products and the requirement of only small quantities of source to produce dose rates usually required for such treatments. Over the volume of interest the ratio of neutron to gamma dose rate (1.5: 1) and the RBE are constant. Twenty radioisotopes are produced in both bone and tissue and the total maximum activity in the pelvis for a typical application in nearly 2 μCi. (GE)

3699 (AERE-R-7765) EXTERNAL RADIATION DOSE TO THE PERSON. Large Scale Monitoring and Recording. Smith, J. W. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jun 1974. 20p. INIS. UK £0.50.

A large-scale personnel dosimetry system at AERE Harwell has been automated and computerized since 1964. The system is based upon the use of the Kodak RM film in a multi-element holder. The film densities and the identification number are read by an automatic densitometer: the radiation doses are calculated by computer, which also stores the records of individual doses. The system currently processes about one quarter of the UK national load of radiation monitoring films. Various record-keeping programs are available. The original program, designed to cater for a large research establishment, has been extended to accommodate a wide variety of users through the service offered by the National Radiological Protection Board. Sample results of the use of these records are given to illustrate the value to the individual, and, integrated summaries, to local management and in the accumulation of large-scale statistics. (auth)

3700 (BARC/I-292) INTRODUCTION TO RADIATION PROTECTION. (Bhabha Atomic Research Centre, Bombay (India)). 1974. 89p. INIS.

The subject of radiation protection and its various aspects are dealt with in an introductory fashion for the use of health physics personnel in general and those working in the health physics units attached to the nuclear reactors in particular. After explaining essential concepts of atom and radioactivity, interaction of various types of radiation with matter is described. Terms frequently used in the radiation protection work are defined. Principles and procedures of radiation protection are covered under topics: (1) biological radiation effects (2) maximum permissible levels of radiation exposure for occupational workers and members of public (3) instruments and methods for radiation monitoring of area, air and personnel (4) contamination control procedures, radioprotective clothes and equipment, decontamination procedures (5) radiation sources and (6) radioactive waste management. Finally, importance of medical supervision through pre-employment, routine and post-employment medical examination and immediate medical treatment in case of accidents is emphasized. (INIS)

3701 (BNL-19900) MOLECULAR MECHANISMS IN RADIATION CARCINOGENESIS: INTRODUCTION. Setlow, R. B. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 7p. (CONF-750443-1). Dep. NTIS $4.00.

From conference on the biology of radiation carcinogenesis; Gatlinburg, Tennessee, USA (7 Apr 1975).

Molecular studies of radiation carcinogenesis are discussed in relation to theories for extrapolating from cellular and animal models to man. Skin cancer is emphasized because of sunlight-induced photochemical damage to DNA. It is emphasized that cellular and animal models are needed as well as molecular theories for quantitative evaluation of hazardous environmental agents. (HLW)

3702 (DHEW/FDA-75-8023) PROGRESS IN RADIATION PROTECTION. (Bureau of Radiological Health, Rockville, Md. (USA)). 1974. 7p. Bureau of Radiological Health, Rockville, MD.

Activities during 1974 in the field of radiation protection are briefly reviewed. Topics discussed include the evaluation of compliance with 1974 Federal regulatory standards for medical and dental x-ray equipment and cabinet x-ray systems used for the inspection of carry-on baggage at airline terminals; the development of standards for laser products, microwave ovens, ultrasound equipment, and phototherapy equipment. Biological research programs and training programs in the field of radiation protection are discussed briefly. (CH)

3703 (RD/B/M-3182) SKIN DOSE ENHANCEMENT DUE TO LEAD LOADED RUBBER GAUNTLETS IN A GAMMA RADIATION FIELD: THE EFFECT OF VARYING THE GAUNTLET THICKNESS. Charles, M. W.; Macfarlane, B. J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Oct 1974. 11p. Dep. NTIS (US Sales Only) $4.00.

Previous work showed that the use of lead-loaded rubber gauntlets in gamma radiation fields can give rise to an enhancement of skin dose. The effect on the dose enhancement of varying the gauntlet thickness is discussed. Depth doses in contact with gauntlets proposed for use are presented and the dose enhancement for thinner gauntlets is predicted. (auth)

3704 ASPECTS OF RADIATION BIOLOGY AND RADIATION PATHOLOGY OBSERVED DURING THE TREATMENT OF CANCER IN MAN. Friedman, M. (New York Univ.). Brit. J. Radiol.; 48: No. 566, 81-96 (Feb 1975).

Published results on the relative radiosensitivities of different tumors in man are reviewed, and emphasis is placed on the pitfalls of attempting to extrapolate experimental results on the influence of biological factors such as hypoxia, variations in radiosensitivity during phases of a cell cycle, growth rate, fractionation patterns, etc. (all obtained under laboratory conditions from simplified cell systems or simple animal tumors) to produce valid predictions of the required tumor lethal dose (TLD) in radiotherapy. Isoeffect recovery curves are compared for different tumors. The observed wide clinical variations in TLD for various tumors (500 to 12,000 rads) and for different tumors of the same type (commonly by a factor of 2, and sometimes by as much as 3.5) suggested that many radiobiological laws which are applicable to radioresistant tumors do not apply to radiosensitive tumors and vice versa. Serial biopsy studies together with clinical observations of volume growth and regression provided the most useful basis for assessing the TLD for a particular tumor. Little is known of the inherent character of the cell influencing its radiosensitivity, yet this is the most important factor. There is strong evidence for multiple subpopulation groups of cells in a tumor, each having characteristic radiosensitivity and chemosensitivity; irradiation was more efficient than methotrexate in producing sublethal damage in all cells. Clinical observations of cancer in man provided the basis for all the deductions; studies in radiobiology should now be directed towards this inherent character of a cell which makes it radiosensitive. (UK)

3705 RADIOBIOLOGICAL ASPECTS AND RADIATION LEVELS ASSOCIATED WITH THE MILLING OF MONAZITE SAND. Costa-Ribeiro, C.; Barcinski, M. A.; Figueiredo, N.; Penna Franca, E.; Lobao, N.; Krieger, H. (Rio de Janeiro Univ.). Health Phys.; 28: No. 3, 225-231 (Mar 1975).

One of the chief problems in industrial radiological health in Brazil concerns 420 people in a plant processing monazite sand, a rare earth mineral containing up to 6% ThO_2 and 0.3% U_3O_8. Radiation hazards associated with ore concentration and chemical treatment were assessed by sampling and measurement of airborne radioactivity, ^{210}Po bioassay in urine, and chromosomal analysis in peripheral blood lymphocytes collected from plant personnel. Results showed that ^{212}Pb ($t_{1/2}$ = 10.64 hr) airborne concentrations range from 0.002 up to 3.9 pCi/l. A size distribution analysis showed that in 88% of ^{212}Pb-bearing aerosols the mean count diameter is below 0.4 μm. Calculated values of airborne long-lived activity as ^{232}Th ranged from 6×10^{-6} up to 1×10^{-4} pCi/l. A few workers had a slight increase in the urinary concentration of ^{210}Po, although results did not show a statistically significant difference between these values and those found in control population. Chromosomal analysis revealed a statistically significant difference in the yield of aberrations for the ore mill workers in one of the plant sections, showing the highest airborne ^{212}Pb concentration. (auth)

3706 TIMING OF KRYPTON-85 CONTROLS. Oscarson, E. C.; Ellett, W. H.; Nelson, N. S. (Environmental Protection Agency, Washington, DC). Health Phys.; 28: No. 3, 302-305 (Mar 1975).

The health risk implications from the environmental buildup of ^{85}Kr through the year 2020 was explored. The potential committed world health effects were evaluated for both the uncontrolled release of ^{85}Kr and the introduction of krypton removal systems at various dates. (UK)

3707 QUALITY CONTROL IN MEDICAL X RAY. Proceedings of the Radiological Health Section of the American Public Health Association meeting held at Atlantic City, New Jersey, November 12-16, 1972. DHEW Publication (FDA) 74-8002, Rockville, MD; Public Health Service (Aug 1973). 36p. GPO.

Separate abstracts were prepared for five papers presented at the meeting. One paper on Standards and How The Various Types of Standards Relate to Quality Control was not available for publication. (HLW)

For abstracts of individual papers see: 3708–3712.

3708 PHYSICIANS, RADIOLOGISTS, AND QUALITY CONTROL. Payne, W. F. pp 1-6 of Quality Control in Medical X Ray. Rockville, MD; Public Health Service (Aug 1973).

Factors involved in quality control in medical x-ray examinations to achieve the least possible exposure to the patient are discussed. It would be hoped that film quality will remain in the position of paramount importance that it must in order to achieve the greatest amount of diagnostic information on each radiographic examination. At the same time, it is hoped that this can be done by further reducing the exposure of the patient to ionizing radiation by the methods that have been discussed; namely, education of the physician, radiologist, and technologist, modern protective equipment and departmental construction, efficient collimation whether automatic or manual, calibration and output measurement of the radiographic and fluoroscopic units, ongoing programs of education within each department of radiographic facility, film badge monitoring, education of and cooperation with the nonradiologic physician, and hopefully, more intensive programs by the National and State Bureaus and Departments of Radiological Health in education and encouragement to the medical community. State Divisions of Radiological Health and Safety are understaffed and cannot possibly accomplish the job they would like to accomplish insofar as regular inspection, education seminars, and training programs within their own boundaries. The training of more radiological health workers is obviously highly desirable, but until we reach this utopia, we in the profession, whether as radiologists, physicians, or technologists, radiation physicists, or radiological health workers must do our utmost to achieve the goal that we have set before us; namely, to achieve the highest quality examination with the least possible exposure to the patient involved. (auth)

3709 QUALITY CONTROL IN RADIOGRAPHY: A PRIMARY RESPONSIBILITY OF THE TECHNOLOGIST. Koenig, G. F. (Univ. of Tennessee, Memphis). pp 7-12 of Quality Control in Medical X Ray. Rockville, MD; Public Health Service (Aug 1973).

The relationship between quality control in radiography and radiation protection is emphasized. Methods of dose reduction discussed are the 0.1 mm fractional focal spot, the use of high speed intensifying screens, and automatic exposure control. The need for recommendations for the establishment of improved systems of radiography is discussed. The development of revised educational concepts for radiologists is considered. (HLW)

3710 ROLE OF THE MEDICAL PHYSICIST IN QUALITY CONTROL IN DIAGNOSTIC X-RAY DEPARTMENTS. Cameron, J. R. (Univ. of Wisconsin, Madison). pp 13-16 of Quality Control in Medical X Ray. Rockville, MD; Public Health Service (Aug 1973).

Medical physicists can play a role in education of future radiologists and technologists by teaching quality control needs and techniques. He or she can also provide service to the diagnostic section by establishing a quality control program. Finally, the medical physicist can play an important role in the development of simple and inexpensive techniques for quality control by radiological technologists. The ongoing work at the University of Wisconsin in this area is to provide quality control in measurement of the effective kVcp, the measurement of the effective focal spot size, the performance of the processing equipment, the output in mR/mAs, and the measurement of the half-value-layer and the total filtration. (auth)

3711 QUALITY CONTROL BY LEGISLATION. Reynolds, J. A. (Picker Corp., Cleveland). pp 17-20 of Quality Control in Medical X Ray. Rockville, MD; Public Health Service (Aug 1973).

Provisions of the Radiation Control for Health and Safety Act of 1968 are described and proposed additional legislation dealing with electrical and mechanical hazards is considered. The administration of the Act by the Bureau of Radiological Health is discussed with regard to collimator performance standards. It is pointed out that the cumulative effect of further efforts to legislate quality control on cost, convenience, and reliability of x-ray and other electromedical apparatus should be weighed in comparison with the practical benefits as each additional regulation is proposed. (HLW)

3712 NATIONWIDE EVALUATION OF X-RAY TRENDS. Shaver, J. W.; Hardin, C. M.; Lubenau, J. O. pp 21-28 of Quality Control in Medical X Ray. Rockville, MD; Public Health Service (Aug 1973).

N.E.X.T. ODIS (organ dose index system) is not a panacea for evaluating how well state and local radiological health programs are meeting their program objectives. It does, however, provide a quality control mechanism that can relate program effectiveness in the reduction of unnecessary patient radiation dose in people-oriented terms, namely the Organ Dose Index. By utilizing a standard patient, the wide range of x-ray exposure technique can be demonstrated. Efforts can then be initiated to modify those techniques involving high exposure and producing high Organ Dose Indices. (auth)

3713 PROCEEDINGS OF THE 27TH ANNUAL CONFERENCE ON ENGINEERING IN MEDICINE AND BIOLOGY. Volume 16. Conference Held at Philadelphia, Pennsylvania, October 6-10, 1974. Chevy Chase, MD; Alliance for Engineering in Medicine and Biology (1974). 535p. (CONF-7410109-). $15.00.

From 27th annual conference on engineering in medicine and biology; Philadelphia, Pennsylvania, USA (5 Oct 1974).

Fifty-four sessions were held on various aspects of engineering in medicine and biology. Approximately ten papers were presented in each session and summaries of the papers are included. A paper on nuclear fueled circulatory support systems describes ^{238}Pu fueled blood cooled heat exchangers and implants using ^{241}Am, ^{9}Be, and ^{90}Sr in dogs. One dog died as a result of an extensive pulmonary neoplasm. Two sessions were devoted to cardiac pacemakers; topics included were data management systems, safety factors, implantation status of the NU-5 nuclear pacemaker, a rechargeable cardiac pacemaker system, and longevity of implantable pulse generators. A session on corporeal imaging included papers on computer processing of chest x-ray pictures, fluoroscopic image enhancement using a storage vidicon, ACTA (automatic computerized transverse axial tomographic)—the whole body scanner, and reconstruction of the image from the ACTA whole body x-ray scanner. (HLW)

3714 MAMMARY GLAND CARCINOMA AND BASALOMA FOLLOWING RADIATION TREATMENT OF HEMANGIOMA OF THE ANTERIOR WALL OF THE THORAX. Knyrov, G. G.; Podlyashchuk, E. L.; Kozlovskii, O. M. (Moscow Scientific Research X-Ray Radiological Inst. of Ministry of Public Health). Med. Radiol.; 22: No. 3, 75-78(Mar 1975). (In Russian).

The development of a mammary gland carcinoma and basaloma in a 26-year old woman as a result of radiation treatment of hemangioma beginning with a first treatment at the age of 8 months and receiving the last treatment at the age of two was reported. The history of the radiation therapy was described insofar as it was known. The results of the histological examination of the carcinoma and basaloma were reported. A mammary gland carcinoma with metastasis in the lymphatic nodes and basaloma of the anterior wall of the thorax developed at the site of the initial radiation therapy. (JSR)

3715 ASPECTS OF EARLY REHABILITATION OF OCCUPATIONALLY EXPOSED PERSONS. Arndt, D.; Schuettmann, W.; Schimmel, W.; Koenig, W. Kernenergie; 17: No. 12, 377-381 (Dec 1974). (In German).

By the instance of future development of nuclear energy the problems relating to the situation of the occupationally exposed persons in the GDR are dealt with. The economic and social aspects of these problems are especially discussed in connection with the medical supervision. The occupationally exposed persons in the field of nuclear energy mostly hold highly specialized jobs, the number of which will increase parallelly with the development of nuclear power. Numerous clearly defined fitness criteria apply to such exposed jobs. These criteria cannot be satisfied by an individual whose general fitness is impaired as a result of severe chronic disease. The above specific problems have been taken into consideration by the Department of Radiation Protection Medicine in the Staatliches Amt fuer Atomsicherheit und Strahlenschultz der DDR (SAAS) which has worked out an action program for early rehabilitation. The program is geared to preventing unfitness by early detection and early intensive treatment of relevant pathological processes. A brief account is given of both the program and organizational steps for its implementation. Major emphasis is laid on chronic diseases of respiratory and circulatory organs, kidneys, liver, skin, and the hematopoietic system. (auth)

3716 DEVELOPMENT OF THE VIEWS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION ON PRACTICAL ASPECTS OF IRRADIATION DOSE DECREASE. Moiseev, A. A. Med. Radiol.; 22: No. 3, 59-62(Mar 1975). (In Russian).

The article is a detailed review of the International Commission on Radiological Protection Publication No. 22 "Implications of Commission Recommendations that Doses be Kept as Low as Readily Achievable." (auth)

3717 MÜELLERIAN-INHIBITING ACTIVITY OF HUMAN FETAL TESTICULAR TISSUE DEPRIVED OF GERM CELLS BY IN VITRO IRRADIATION. Josso, N. (Hospital des Enfants-Malades, Paris). Pediat. Res.; 8: No. 8, 755-758(Aug 1974).

Fragments of testicular tissue from seven human fetuses were explanted in three organ-culture dishes for each fetus. One remained unirradiated while the others were submitted to, respec-

tively, 500 and 700 rads of ^{60}Co γ rays. After an interval of 1 to 2 weeks, the müellerian-inhibiting activity of the explants was tested using the 14½-day-old rat müellerian duct as end organ and the number of germ cells present in 50 orthogonal sections of seminiferous tubules was determined on a minimum of 10 histologic sections. In control explants, only 12.9% of the original number of germ cells were normal after 1 to 2 weeks in vitro. The mortality of germ cells was increased by γ rays; only 7% of their original number surviving 500 rads, and 3% 700 rads. Müellerian-inhibiting activity of both control and irradiated explants was normal. (auth)

3718 EFFECT OF DIFFERENCES IN THE ELEMENTAL COMPOSITION OF HUMAN PHANTOMS ON THE ABSORBED ENERGY FRACTION OF EXTERNAL PHOTON RADIATION. Koblinger, L. (Central Research Inst. for Physics, Budapest). Acta Biochim. Biophys. Acad. Sci. Hung.; 7: No. 2, 189-192(1972).

The elemental composition of the human body depends on several factors such as age, sex, natural environment, etc. However, for phantom measurements and calculations average values characteristic of the given population have to be chosen. A number of body compositions have been published in past years. Naturally, these are not identical with each other, there are smaller or greater differences between them. The effect of these differences on the absorbed fractions of external photon radiations (i.e. the ratio of the absorbed and incident energies) is the subject of the present study. (auth)

3719 DOSE FIELDS DURING THE USE OF MOBILE X-RAY APPARATUS. Levin, V. A.; Zikeev, M. S.; Lukin, M. I. (Moscow Medical Inst.). Med. Radiol.; 22: No. 3, 69-71(Mar 1975). (In Russian).

The scattered radiation field produced during the use of mobile x-ray devices was measured on phantoms using a number of different types of x-ray devices. The dose levels of the scattered radiation at various distances from the x-ray tube were determined and the values obtained were tabulated. Typical isodose curves were given. The danger of the scattered x radiation to the technician was discussed. (JSR)

3720 USE OF COMPUTERS FOR CALCULATION OF SPATIAL DISTRIBUTION OF ABSORBED DOSE DURING THE USE OF PROTECTIVE SCREENS IN TELEGAMMA THERAPY. Sevast'yanov, A. I.; Korf, N. N.; Ksenofontov, A. I. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 22: No. 3, 63-69(Mar 1975). (In Russian).

A procedure for the computer calculation of the spatial distribution of the absorbed dose in the shadow zone, the penumbra zone, and the visual range was developed. The assumptions made for the calculations for each zone was tabulated. The analytical representation of the problem, projection of the source onto the base plane of the protective shield, and the division of the source into elementary areas were described. The data needed for the calculation were tabulated. (JSR)

3721 HEALTH PROTECTION OF RADIATION WORKERS. Norwood, W. D. Springfield, IL; Charles C Thomas Publisher (1975). 450p. $27.50.

Essential information on the health protection of radiation workers which has accumulated since the advent of nuclear fission thirty years ago is presented in simple terms. Basic facts on ionizing radiation, its measurement, and dosimetry are presented. Acute and chronic somatic and genetic effects are discussed with emphasis on prevention. Radiation protection standards and regulations are outlined, and methods for maintaining these standards are described. Diagnosis and treatment of radiation injury from external radiation and/or internally deposited radionuclides is considered generally as well as specifically for each radioisotope. The medical supervision of radiation workers, radiation accidents, atomic power plants, and medicolegal problems is also covered. (853 references) (CH)

3722 GLOMUS JUGULARE TUMORS: EFFECTS OF RADIOTHERAPY. Spector, G. J.; Compagno, J.; Perez, C. A.; Maisel, R. H.; Ogura, J. H. (Washington Univ., St. Louis). Cancer; 35: No. 5, 1316-1321(May 1975).

Twenty glomus jugulare tumors which received x-ray therapy are analyzed. Postirradiation angiography showed persistent tumor vessels and abnormal channels in eight patients. Histologic study of five postirradiation specimens showed that tumor cells persisted after treatment in a significant proportion of the patients. Vascular response was nonuniform and consisted of endothelial hyperplasia and subendothelial hyalinization. Radiotherapy is not always effective in the permanent eradication of the tumor when used as the only modality of treatment in patients with large glomus jugulare tumors. Because of the frequent recurrence after irradiation or surgical resection, a combination of both modalities offers the patient the best probability of cure. (auth)

3723 WORKING WITH PLUTONIUM. Mole, R. H. Lancet; 1: No. 7908, 701-702(22 Mar 1975).

The current controversy over differing published estimates of the risks of leukaemia, lung cancer, and bone cancer arising from exposure to plutonium is reviewed, and the basis of some of these estimates challenged. The sometimes ill-informed bias displayed in recent newspaper reports has been ascribed either to an understandable, but unjustified, lack of trust in data from British Nuclear Fuels Ltd., or alternatively to political opposition to nuclear power development - the latter being the less wholesome explanation. It is suggested that the staff of the newly established Health and Safety Commission should have responsibility for the custody of the confidential details of individual cases. In this way research into the possible relationships between exposure and injury could be based on full access to the available data, while still preserving the legitimate commercial interests of employers faced with potential compensation claims. (UK)

3724 TECHNOLOGICALLY ENHANCED NATURAL RADIATION ENVIRONMENT. Gesell, T. F.; Prichard, H. M. (Texas Univ., Houston). Health Phys.; 28: No. 4, 361-366(Apr 1975).

From international symposium on radiation protection: philosophy and measurement; Aviemore, Eng. (Jun 1974).

A new category for human radiation exposure, technologically enhanced natural radiation (TENR), is proposed. The purpose of the new category is to permit clear distinction between truly natural human radiation exposure and exposure that occurs due to alteration of the natural sources by non-nuclear technology. Examples of TENR, such as radium emission from coal fired plants, radon in natural gas, radium in fertilizer, radon in water and enhanced cosmic ray exposure in high altitude aircraft are discussed. It is concluded that creation of the TENR category would be useful because it would facilitate direct comparison of increments to the radiation environment due to nuclear and conventional activities, it would direct research to TENR, which would perhaps uncover significant human exposure, and it would permit regulatory authorities to control unambiguously TENR exposures without having to decide in each instance whether the exposure was nautral or man-made. (auth)

3725 STRUCTURAL CHROMOSOME DISORDERS IN LYMPHOCYTES OF HUMAN PERIPHERAL BLOOD, INDUCED BY IRRADIATION WITH GAMMA RAYS OF ^{60}Co. Todorov, S.; Mileva, M.; Bulanova, M.; Ivanov, B. Suvrem. Med.; 25: No. 2, 11-14(1974).

A study was made of the quantitative characteristics of the structural chromosome aberrations in lymphocytes of human peripheral blood, irradiated in vitro with different doses of ^{60}Co gamma radiation, as well as the relative biological effectiveness of the same radiation. A comparatively low incidence of chromosome aberrations was detected, growing along with dose increase and this is proportionally different for the various types of chromosome disorders. The study of the relative biological effectiveness (RBE) of cobalt gamma radiation, as compared to roentgen radiation from 180 kV, shows an average 0.97 RBE for the chromosome fragments and an average 1.01 for the cellular aberrations. The quantitative dependences and standard curves in irradiation of human lymphocytes of the peripheral blood may be taken as a basis of biological dosimetry in accidental acute irradiations with gamma rays. (Abstr. Bulg, Sci. Med. Lit.)

3726 DOSIMETRIC MODEL FOR THE GASTROINTESTINAL TRACT. Skrable, K. W.; Chabot, G.; Harris, J.; French, C. (Lowell Technological Inst., MA). Health Phys.; 28: No. 4, 411-427(Apr 1975).

A dosimetric model is proposed for the gastrointestinal tract based upon the physiological model of EVE (Health Phys.; 12: 131 (1966)). A general equation describing the kinetics of linear first order phenomena is applied to obtain the burden of radionuclides or disintegrations in the contents of the various segments of the GI tract. The model gives equations for the calculation of the dosimetric average dose equivalent and dose equivalent rate to an entire segment as well as instantaneous values at any location within a given segment as applicable to single or continuous uptakes of parent and daughter radionuclides. Allowance is made for both the absorption of radionuclides as well as mass from the contents of all segments; although, this is not always considered significant. The model permits the determination of the quantities of a radionuclide absorbed into the blood, the ratio of daughter to parent disintegrations, and the maximum to average dose equivalent rate in a particular segment of the GI tract. Numerical examples are given for various intakes. Maximum permissible daily ingestion rates of fictitious single soluble and insoluble radionuclides with an effective energy term of unity in all segments are given over a large range of half-lives and are compared to values calculated on the basis of current ICRP recommendations. It is proposed that ratios of

the maximum to dosimetric average dose equivalent rate be used to define a distribution factor to take into account relatively high dose rates at particular locations within a segment of the GI tract. All equations have been derived using the more fundamental units of atoms or disintegrations and disintegration rates rather than the more popular μCi and μCi-day units. The former units are more fundamentally related to dosimetric quantities of interest. (auth)

3727 IN VIVO DOSE ESTIMATES FOR A-BOMB SURVIVORS SHIELDED BY TYPICAL JAPANESE HOUSES. Jones, T. D.; Auxier, J. A.; Cheka, J. S.; Kerr, G. D. (Oak Ridge National Lab., TN). Health Phys.; 28: No. 4, 367-381(Apr 1975).

The Atomic Bomb Casualty Commission (ABCC) has radiation exposure estimates for most of the 117,000 A-bomb survivors in the Master Sample; however, these estimates, denoted T65D (CHEKA, 1965; NOBLE, 1967; HUBBELL, 1960), actually predict absorbed dose or kerma to infinitesimal amounts of biological tissue under exact analogue exposure conditions, except for the absence of the specific survivors. These estimates, often referred to as "T65D doses," are inadequate to assess the radiation insult to a survivor or to a critical biological organ of the survivor, because they neglect the attenuation and multiple scattering by the body of the survivor. In the present work, a method is provided to use the "T65D," or incident neutron radiation and incident photon radiation, to estimate dose to an organ such as the thyroid gland or to a specific site of interest such as the isthmus of the thyroid gland or even to survivors who were in utero at the time of exposure. The method also permits the assessment of the additional radiation insult from photons produced by neutron interactions in the body. Estimates of absorbed doses to specific organs, especially deep seated organs within the body, will allow for more accurate estimates of risk. (auth)

3728 ASSESSMENT OF EXPOSURE AND RISK. Proceedings of the Symposium Held in London, England, November 23–24, 1972. Duck, B. W. (ed.). London; Society of Occupational Medicine, Royal College of Physicians (1972). 173p.

Nine papers were presented in sections entitled: at what stage is the measurable or identifiable effect of a chemical or physical agent to be regarded as pathological; quantitative assessment of hazards of exposure–acceptable and unacceptable risks; problems in establishing aetiology of disease–in relation to "normal" incidence and "natural" background; and medico-legal consequences and assessment of compensation. One paper from the first section and one from the third were in NSA scope and separate abstracts have been prepared for them. (UK)

For abstracts of individual papers see: 3729 and 3730.

3729 RADIATION DOSE LIMITS. Mole, R. H. pp 11-25 of Proceedings of the Symposium on the Assessment of Exposure and Risk. Duck, B. W. (ed.). London; Royal College of Physicians, Society of Occupational Medicine (1973).

From symposium on the assessment of exposure and risk; London, England (23 Nov 1972).

The subject is discussed under the following headings: the biological basis for concepts used in radiation protection (tolerance dose, threshold limit, stochastic effects); how are dose limits to be set for stochastic kinds of damage (quantitative relationship between dose of a toxic agent and frequency of effect, and decision about level of effect that is socially acceptable); radiation effects in irradiated individuals (malignant disease); a system of dose-limitation (ICRP recommendations); special characteristics of ionizing radiation as a toxic agent. (UK)

3730 FACTORS CONTROLLING THE RECOGNITION OF LUEKAEMIA AND CHILDHOOD CANCERS. Stewart, A. M. pp 109-124 of Proceedings of the Symposium on the Assessment of Exposure and Risk. Duck, B. W. (ed.). London; Royal College of Physicians, Society of Occupational Medicine (1973).

From symposium on the assessment of exposure and risk; London, England (23 Nov 1972).

Both in relation to the delayed effects of low-level radiation and in relation to the changing patterns of leukemia mortality there has been a long period of false impressions and conflicting theories. It is anticipated that when more scientists have had more time to relate the findings of the Oxford survey to other observations a number of outstanding problems will be resolved. There is, however, a quantity of data relating to this on-going retrospective survey which has not yet been published. The position is first discussed in relation to some of the problems related directly or indirectly to children. This is followed by a more detailed discussion of the problem why so many prospective surveys failed to detect the carcinogenic effects of prenatal irradiation. Finally some new data are presented which are interpreted as evidence that there is no need to fear vertical transmission of human cancers, even when they are radiation-induced, unless they affect the retina; in which case surgery may overcome the usual restraints imposed by nature on lethal genes. (auth)

3731 TOTAL-BODY IRRADIATION AND HUMAN CHROMOSOMES. IV. Cytogenetic Follow-Up Studies 8 and 10½ Years After Total-Body Irradiation. Goh, K. O. (Oak Ridge Associated Universities, TN). Radiat. Res.; 62: No. 2, 364-373(May 1975).

Chromosomal breaks and abnormal chromosomes were found in the peripheral blood and bone marrow cultures from six persons who were accidentally exposed to total-body irradiation 8 and 10½ yr previously. These type of abnormalities were found in these same patients by Bender and Gooch 2½ yr and 3½ yr after the radiation exposure and by us 7 yr after the accident. The frequencies of the abnormalities remained higher than the normal controls. There is good evidence that there is an increased incidence of cancer and leukemia among populations exposed to radiation. It has been suggested that chromosomal aberrations are involved in the development of some cancer or leukemia in irradiated persons. However, none of our patients has these diseases. It is possible that the development of clinical cancer or leukemia (phenotype) depends not only on the presence of abnormal cells (genotype), but also, on factors that give advantage to these abnormal cells. (auth)

3732 EXPOSURE REDUCTION USING NEW SCREEN/FILM COMBINATION. Ardran, G. M. (Oxford Univ.); Langmead, W. A.; Crooks, H. E. Brit. J. Radiol.; 48: No. 567, 233-234 (Mar 1975).

An assessment of the performance of a new film-screen combination called the Trimax System (3M Organization) has been carried out. Although the detailed nature of the phosphors used has not been revealed it is thought that rare earth salts are used in the preparation of these screens, and that the films are orthochromatic. Two types of both screen and film are available. The performance of all four combinations has been compared with that of other common film-screen combinations with respect to speed, radiation, quality, and image resolution using test objects and also under clinical conditions. The advantages of the Trimax System were those of reduction in radiation dose to both patients and staff, convenience in use in mobile radiography and cost-benefit, despite the relatively high cost of the screens. The disadvantages included the need for different safe lights, the cost of the screens, and the stress and pressure sensitivity of the fast film. (UK)

3733 REVIEW OF KNOWN DATA AND SOME NEW FACTS ON THE ACCIDENTAL EXPOSURE IN THE VINCA "ZERO POWER" REACTOR. Szirmai, E. (Inst. of Nuclear Engineers, Stuttgart). J. Inst. Nucl. Eng.; 16: No. 1, 15-17(Jan 1975).

The "Vinca" accident occurred in 1958 at the Institute of Nuclear Sciences, Yugoslavia. It took place when a Zero Energy Reactor became over active during experimental work. The accident involved the exposure of five men and one woman to γ radiation and relatively low energy neutrons. Its main features are here summarized. The alarm system failed to notify the danger, which was detected by the smell of O_3. The duration of the radiation was about 10 min., and a mixed γ-neutron dosage of about 680 rem was estimated. The symptoms of acute radiation sickness developed within a few hours, and were followed by a latent period until the end of the third week. Severe symptoms then developed. Details are given of blood counts and blood disorders, and of urinary and genital disorders. Medical observations on survivors are summarized. (UK)

3734 REDUCING MEDICAL EXPOSURE TO IONIZING RADIATION. Morgan, K. Z. (Georgia Inst. of Tech., Atlanta). Amer. Ind. Hyg. Ass. J.; 36: No. 5, 358-368(May 1975).

The author discusses the dangers of indiscriminate and uninformed use of medical x-ray facilities. He points out a lack of effective standards, controls, and practices to minimize exposures to x ray and to prevent the excessive use of diagnostic x-ray examinations. A list of practices whereby an individual can minimize his possible exposures to x rays is presented. Several approaches to the question of acceptable exposure levels are considered. (auth)

3735 YEAR BOOK OF NUCLEAR MEDICINE, 1975. QUINN, J. L. III, (ed.). 1975 Year Books. Chicago; Year Book Medical Publishers, Inc. (1975). 399p. $22.75.

Literature published through September, 1974, is reviewed under the following headings: radiation physics and instrumentation, radiochemistry and radiopharmacology, health physics and radiobiology, the endocrine system, the hemopoietic and lymphatic systems, the genitourinary system, the central nervous system, the gastrointestinal system, the heart and great vessels, the pulmonary system, and the osseous and cartilaginous systems. (HLW)

3736 IONIZING RADIATION AS A CARCINOGEN: PRACTICAL QUESTIONS AND ACADEMIC PURSUITS. Mole, R. H. (Medical Research Council, Harwell, Eng.). Brit. J. Radiol.; 48: No. 567, 157-169(Mar 1975).

Cancer is naturally very common, and practical questions about the possibility of radiation-induced harm are often questions about what in other contexts would be called background noise. Central to the question of whether small radiation exposures are carcinogenic is the effect of ante-natal radiography. A comparison of singleton and twin births with radiography rates of 10 and 55 per cent respectively showed that radiography must be the main cause of the elevated frequency of malignant disease. In Japanese bomb survivors, most radiation-induced cancer has been found in those irradiated in adult life, less in those irradiated in childhood and adolescence, and least for exposure in utero. Specific biological differences between different kinds of malignant disease in their induction by ionizing radiation are becoming increasingly evident. When dose-response relationships for observed cancer frequencies are to be used as evidence about dose-response relationships for cancer induction, it will always be necessary to allow for the concomitant cell sterilization. When this is done, there is little support for linearity as the method of extrapolation when making predictions about possible effects of low doses but the absence of threshold seems scientifically inescapable. In cellular terms, radiation induction of cancer must be a very rare phenomenon, so rare compared with cell sterilization or mutation induction, that the general corpus of radiobiological understanding may be inapplicable. (auth)

3737 ENHANCEMENT OF THERAPEUTIC RATIO IN RADIOTHERAPY OF BRAIN NEOPLASMS. DeGinder, W. L.; Mistry, V. (Capital Area Radiation and Research Center, Austin, TX). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 459-470(Mar 1975).

For a given tumor dose, the radiation effect and therapeutic ratio may be enhanced by the technique of daily fractionation. Full potential of teletherapy is achieved only when each fraction of the total treatment produces more radiobiological damage in the tumor than in normal tissues unavoidably irradiated. This requires three or more converging beams, all fields treated at each visit. With very modest shop facilities, it is possible to construct a large variety of alloy blocks to shape and modify photon beams. The original design and construction of these devices requires several man hours, but there are at least three subsequent compensations: the mechanism of setup and treatment each day is greatly simplified so three or four fields can be treated in a very short time; since accuracy is improved and some potential technical errors are eliminated, larger tumor doses can be given safely at each fraction; and symptomatic and visible effects of radiotherapy are minimized or eliminated when the daily dose fraction in normal tissues has been deliberately minimized for each individual patient. (auth)

3738 IMMUNOSUPPRESSION FOLLOWING RADIATION THERAPY FOR CARCINOMA OF THE NASOPHARYNX. Wara, W. M.; Phillips, T. L.; Wara, D. W.; Ammann, A. J.; Smith, V. (Univ. of California, San Francisco). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 482-485(Mar 1975).

From 56th annual meeting of the American Radium Society; Maui, Hawaii (21 Apr 1974).

Eleven patients treated for nasopharyngeal carcinoma with standard radiation therapy were found to have depressed cell mediated immunity. Post-treatment their total lymphocyte count was decreased by 60 percent. Eight of 11 patients had depressed T-cell rosettes, and 9 of 10 had abnormal lymphocyte response to PHA. Immunosuppression was probably related to irradiation of large blood volumes, irradiation of the thymus, and malnutrition. (auth)

3739 THYMUS-DEPENDENT LYMPHOCYTE LEVELS DURING RADIATION THERAPY FOR BRONCHOGENIC AND ESOPHAGEAL CARCINOMA: CORRELATIONS WITH CLINICAL COURSE IN RESPONDERS AND NONRESPONDERS. Dellon, A. L.; Potvin, C.; Chretien, P. B. (National Institutes of Health, Bethesda, MD). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 500-511(Mar 1975).

From 56th annual meeting of the American Radium Society; Maui, Hawaii (21 Apr 1974).

The major conclusion from this study, therefore, is that in patients with bronchogenic and esophageal carcinoma, quantitation of cellular immunity by assay of T cell levels and serial determination of the effects of therapy on T cell levels may offer a rational basis for the selection of treatment modalities and the early determination of the effects of therapy. The increasing numbers of clinical protocols utilizing radiation therapy in combination with other modalities in an attempt to improve the cure rates of these tumors warrant an early determination of the usefulness of assay of T cell levels in the design and monitoring of these regimens. (auth)

3740 COMBINED IRRADIATION AND CHEMOTHERAPY FOR SARCOMAS OF THE PELVIS IN FEMALES. Smith, J. P.; Rutledge, F.; Delclos, L.; Sutow, W. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 571-576(Mar 1975).

From 56th annual meeting of the American Radium Society; Maui, Hawaii (21 Apr 1974).

Thirty-eight patients with advanced, recurrent, or metastatic pelvic sarcomas were treated with combined irradiation and chemotherapy. Fourteen of these patients are presently alive and well without evidence of disease for 10 to 79 months following completion of their therapy. The complications of this combined therapy have been severe, but few, if any, of these patients could have been expected to live with conventional therapy with either chemotherapy alone or irradiation therapy alone. A decrease in the dosage of vincristine would have prevented several of the deaths. A change in order of administering whole pelvis and whole abdomen irradiation combined with chemotherapy possibly will prevent some of the bowel injuries associated with this treatment. (auth)

3741 CHILDHOOD RHABDOMYOSARCOMA. Analysis of Coordinated Therapy and Results. Fernandez, C. H. (M. D. Anderson Hospital and Tumor Inst., Houston, TX); Sutow, W. W.; Merino, O. R.; George, S. L. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 588-597(Mar 1975).

From 56th annual meeting of the American Radium Society; Maui, Hawaii (21 Apr 1974).

The current utilization of an intensive coordinated therapy program (surgery, radiotherapy, and intensive multidrug chemotherapy) has increased the success rate in treatment for rhabdomyosarcoma in children. A 68 percent 3 year survival and 89 percent local control of rhabdomyosarcoma of head and neck substantiate this. These results suggest that surgical procedures regarding rhabdomyosarcoma primary in other sites require reevaluation and possible modification. (auth)

3742 USE OF SILICONE COMPENSATORS IN RADIOTHERAPY. Edland, R. W.; Tautin, F. S.; Boge, R. J. (Gundersen Clinic, Ltd., La Crosse, WI). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 638-642(Mar 1975).

In the two patient histories presented, the usefulness of silicone has been demonstrated. By utilizing silicone, no special materials are necessary. Those which are already present in the dental office are more than adequate. The silicone will not distort over the treatment period and can be repositioned accurately to ensure uniformity of the dose. It is also easily cleaned and stored for daily use. It can be used to improve the plane of the surface tissue and provide "build-up" as well as to fill dead space which helps assure accurate assessment of the magnitude and distribution of the desired dose. (auth)

3743 SOME PARTICULARITIES OF THE CLINICAL COURSE AND TREATMENT OF INJURIES TO THE MAXILLOFACIAL REGION UNDER THE CONDITIONS OF ACUTE RADIATION ILLNESS. Kavrakirov, V.; Georgiev, N. Voenno Med. Delo; 28: No. 2, 9-13(1973). (In Bulgarian).

Attention was paid to some specific peculiarities of the clinical course and specialized treatment of combined radiative injuries to the maxillofacial regions resulting from the anatomic functional and physiological particularities of this region. It is emphasized that the surgical dressing of the wound should be performed with minimal trauma to the tissue and at the same time completely, with heightened radicalism. The careful dressing of the bone wound is especially pointed out as well as its hermetic sewing at the side of the oral cavity. When the jaws are fixed it is recommended that the means of the inter-maxillary fixation should be restricted within the limits of the latent period of acute radiation illness. Preference is given to the fixation methods respecting the oral mucosa, gingival margin and periost, that maintains the patient's feeding and the hygiene of the mouth. (auth)

3744 POSTOPERATIVE RADIATION IN THE TREATMENT OF CARCINOMA OF THE BREAST. Johnstone, F. R. C. (Univ. of British Columbia, Vancouver). Amer. J. Surg.; 128: 276-281 (Aug 1974).

As a result of a decision to carry out preliminary selective biopsy on patients with operable stage I and II (Manchester) carcinoma of the breast followed by radical mastectomy, accurate knowledge became available of lymphatic metastases to all sites, including internal mammary nodes. Of 121 patients with pathologic stage I disease (those with no evidence of lymphatic metastases), 88 received prophylactic postoperative radiation and 33 were not irradiated. All were followed up for ten years. Of the irradiated

group, fourteen showed evidence of distant recurrence; of these, seven died in the first three years after treatment whereas only three in the nonirradiated group showed distant recurrence and none of them died before the fifth year. Although short of statistical significance, this result suggests that prophylactic radiation directed to areas shown to be free of lymphatic metastases, as would be expected, does no good in the prevention of local recurrence and may do harm by an increase in distant metastases resulting in the earlier death of the patient. (auth)

Vertebrates

Refer also to abstracts 3558 and 3661.

3745 (COO-3334-6) THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS. Sweet, W. H.; Wellum, G.; Tolpin, E.; Messer, J. R. (Massachusetts General Hospital, Boston (USA)). 23 Apr 1975. Contract AT(11-1)-3334. 49p. Dep. NTIS $5.50.

Progress is reported in the preparation and testing of boron compounds for use as targets in the neutron capture therapy of neoplasms. The synthesis and structural confirmation of the disulfide, $B_{12}H_{11}SSB_{12}H_{11}^{-4}$ is reported as well as a new structural model for its mono-oxidized derivative, $B_{12}H_{11}SOSB_{12}H_{11}^{-4}$, which showed useful tumor: blood concentration ratios in rats after three I. V. injections. The material, $B_{12}H_{11}(SH)_2^{-2}$, was isolated and identified from impure $Cs_2B_{12}H_{11}SH$. The former anion was shown to be responsible, in its oxidized form, for the excellent tumor uptake results shown by impure $B_{12}H_{11}SH^{-2}$ in the past. As a consequence of this work, a borane polymer was synthesized which has shown extremely encouraging tumor uptake properties. The synthesis of this polymer depended on our production and characterization of the first stable thiyl radical at room temperature, $B_{12}H_{11}S:^{-2}$. The retesting of certain phosphate boranes is reported. And a reagent, namely acetyl sulfenyl chloride, $ClSCOCH_3$, has been found which will produce $B_{12}H_{11}SH^{-2}$ in a laboratory synthesis. The ability of sulfur derivatives of $B_{12}H_{11}SH^{-2}$ to bind to proteins was examined, as was the blood distribution of two of these interesting boranes. The amount of non-protein bound borane was related to the rate of blood clearance of the borane in rats. Progress is also reported on dog irradiation experiments. (CH)

3746 (RLO-2227-T8-6) RADIOSENSITIVITY OF THE ROUGH-SKINNED NEWT. Willis, D. L.; Lappenbusch, W. L. (Oregon State Univ., Corvallis (USA). Dept. of General Science). 1974. 44p. (CONF-750503-9). Dep. NTIS $5.25.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Newts were collected locally and maintained unfed at 10°C both before and after irradiation. Whole-body exposures ranging up to 80 kR were given with 250 kVp x rays, 300 kVp x rays, and ^{60}Co gamma rays. The mean survival time-exposure curve was sigmoid, following the typical appearance of such curves for mammalian species. A dose-independent region extending from roughly 700 to 5,000 R was evident. A variety of skin lesions and depigmentation effects were noted at exposures above 250 R, whose time of appearance decreased with increasing dose. A total of 832 newts were used in this phase of the study. Assuming that hematopoietic damage was primarily responsible for deaths below 700-800 R, additional studies of hematopoiesis were initiated. The effect of a 650 R-exposure on liver weight, spleen weight and concentration of circulating red blood cells for 1½ months post-irradiation was assessed. The results indicate a progressive state of anemia. This was further substantiated by a study of ^{59}Fe incorporation by red blood cells at intervals up to one month for five exposures ranging up to 1000 R. (auth)

3747 TOLERANCE INDUCTION WITH BOVINE γ GLOBULIN IN MOUSE RADIATION CHIMAERAS DEPENDS ON MACROPHAGES. Lukic, M. L.; Leskowitz, S. (Belgrade Univ.). Nature (London); 252: No. 5484, 605-607(13 Dec 1974).

Experimental work is reported in which it was shown that the administration of carrageenin, which is known to be toxic to macrophages, destroys resistance to bovine γ globulin in BALB/c mice. Spleen and bone marrow cells transferred from BALB/c mice to irradiated DBA/2 mice to form chimaeras do not show the characteristic BALB/c resistance to induction of tolerance until 12 weeks after transfer. Carrageenin is a polysaccharide obtained from seaweed. (UK)

3748 COMPARISON OF THE EFFECTS OF RADIATION ON TUMOUR GROWTH DELAY AND CELL SURVIVAL. Effect of Radiation Quality. McNally, N. J. (Hammersmith Hospital, London). Brit. J. Radiol.; 48: No. 566, 141-145(Feb 1975).

Measurements were made of the effects of 250 kV x rays and cyclotron produced neutrons on the delay in growth of a rat fibrosarcoma (RIB_5C) and on tumor cell survival assayed in vitro after irradiation in vivo. For doses above 300 rads of neutrons the RBE for cell survival was greater than that for tumor growth delay. This may be due to x rays causing a greater delay in cell proliferation than neutrons for a given level of cell survival. This would be the opposite effect to that found by Barendsen and Broerse (European J. of Cancer, 1969, 5, 373), irradiating a rat rhabdomyosarcoma. Another possibility was that measurements of cellular radiosensitivity that involved removal of cells from their normal environment may have led to incorrect estimates of cell survival in situ. A plot of the RBE for growth delay against the reciprocal of the neutron dose indicated that the dose level at which the RBE became dependent on the fraction of hypoxic tumor cells was larger than that for cell survival, indicating a smaller effective hypoxic fraction than that estimated from the cell-survival curves. (auth)

3749 CARCINOGENIC EFFECTS OF 100, 250, AND 500 RAD X RAYS ON THE RAT THYROID GLAND. Doniachi, I. (London Hospital). Brit. J. Cancer; 30: No. 6, 487-495(Dec 1974).

Male rats were given 0, 100, 250, or 500 rad x rays to the thyroid gland at 9 to 12 weeks of age and killed 18 to 20 months later. No thyroid tumors were found in the unirradiated animals, a few follicular adenomata developed after 100 and 250 rad and a follicular carcinoma after 500 rad. A similar group was set up and maintained on a diet with thyroxine added in a quantity to give a daily consumption of 5 to 6 μg/100 g body weight in order to suppress TSH secretion. Thyroid tumor production was considerably lowered. At the termination of the experiment the efficiency of the TSH suppression was tested by measurement in some rats of T/S ^{131}I concentration ratios and in others of the 24 h% ^{131}I thyroid uptake. In some rats TSH was totally suppressed; in others partially suppressed. A further group was set up and maintained on the goitrogen 0.1% aminotriazole in the drinking water to cause excessive TSH secretion. All its subgroups, including unirradiated animals, developed numerous follicular adenomata and carinomata. Enhancement of carcinoma production was present in the 500 rad subgroup. It was concluded that the development of thyroid adenomata after the above doses of x radiation may occur without an excessive rise in TSH secretion, that suppression of TSH lowers radiation tumor production and that therefore TSH may play a permissive role in the development of thyroid tumors following low dose x radiation to the thyroid gland. (auth)

3750 EFFECT OF POST-IRRADIATION TEMPERATURE ON VIABILITY OF RAT THYMOCYTES. Ohyama, H.; Yamada, T.; Inoue, Y. (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 26: No. 6, 535-546(Dec 1974).

Rat thymocyte suspension were exposed to x rays (50 to 1000 R). After incubation with 10 mM glucose at 37°C, pH 7.4 for 2 to 8 hours, cell viability, ATP, fructose-1, 6-diphosphate, and dihydroxyacetone phosphate were measured. The results confirmed the close relationship between viability (judged by a dye-exclusion test) and ATP content, and the correlation between decreasing ATP and the accumulation of these two glycolytic intermediates. Lowering the incubation temperature from 37°C to 25°C, or pH from 7.4 to 6.1 prevented the appearance of dead cells, ATP depletion, and the accumulation of the intermediates. On the basis of this experimental evidence, a new hypothesis for the mechanism of interphase death, namely, the stimulation of ATP degradation through an abnormal enhancement of the phosphofructokinase reaction, was proposed. It explained satisfactorily many experimental results, including the marked post-irradiation temperature effect. (auth)

3751 EFFECT OF PRE-IRRADIATION GROWTH CONDITIONS ON THE RELATIVE RADIOSENSITIVITIES OF MAMMALIAN CELLS AT LOW OXYGEN CONCENTRATIONS. Cullen, B.; Lansley, I. (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 26: No. 6, 579-588(Dec 1974).

The value of K depends on the pre-irradiation growth conditions of the mouse Ehrlich ascites tumor. Cells were grown either in vivo or in vitro but were irradiated and assayed in vitro. K was 1.8 times greater for cells grown in vitro, demonstrating that K is not invariant for mammalian cells, nor even for the same cell-line. (auth)

3752 BRUGIA PAHANGI MODEL INFECTIONS: SUSCEPTIBILITY OF MONGOLIAN JIRDS AFTER X-IRRADIATION OR PRIOR INFECTION AND PATHOLOGIC STUDIES IN GOLDEN HAMSTERS. Malone, D. V. M.; Brooks, J. Jr. Athens, GA; Univ. of Georgia (1974). 165p. University Microfilms Order No. 75-8178.

Thesis (Ph. D.).

Comparisons were made in male jirds of infections induced by inoculation of 43 to 50 infective larvae of Brugia pahangi via the subcutaneous or intraperitoneal route, and the effect of sub-lethal total body x-irradiation on infections induced by each route. In 4 separate experiments, small increases in percentages of adult worms recovered and increased microfilaremia levels were observed in jirds inoculated subcutaneously with infective larvae of B. pahangi within 24 hours after exposure to 700 R total body x-irradiation. In two experiments in which jirds were inoculated intraperitoneally, similar exposure to x-irradiation did not enhance the susceptibility of irradiated jirds over control jirds. In non-irradiated jirds infected intraperitoneally, larger numbers of adult worms were recovered as compared to non-irradiated jirds infected subcutaneously. The majority of worms were from the peritoneal cavity, and worms were significantly larger than those from vascular sites. Total and differential white blood cell counts indicated that a sharp rise in eosinophils and a transient mild leukocytosis occur at the time of the fourth molting period. Transfer of 14 to 16 day-old developing larvae of B. pahangi from the peritoneal cavity of donor jirds to the peritoneal cavity of recipient jirds resulted in recovery of worms from only the peritoneal cavity, the accumulation of large numbers of microfilariae in the peritoneal cavity, and very low microfilaremia levels in the peripheral blood. Worm burdens resulting from worm transfer were higher than that expected after inoculation of infective larvae intraperitoneally. (Diss. Abstr. Int., B)

3753 INVESTIGATIONS ON UCS-CS MEDIATION IN RADIATION-INDUCED CONDITIONED TASTE AVERSION. Burns, T. C. Athens, GA; Univ. of Georgia (1974). 70p. University Microfilms Order No. 75-8101.

Thesis (Ph. D.).

Groups of 8 male Sprague-Dawley rats were used in an investigation of procaine and dimenhydrinate effects on radiation-induced taste aversion learning. Neither the local anesthetic procaine, administered intraperitoneally, nor the antinausea drug dimenhydrinate, administered intramuscularly, blocked acquisition of aversion to saccharin flavored water. Control animals confirmed that saccharin preferences appeared normally in non-irradiated animals, and that the drugs produced no aversion in the absence of radiation. Another investigation, using groups of 5 female Sprague-Dawley rats, showed a failure of dimenhydrinate in blocking the acquisition of a rotation-induced conditioned taste aversion. Two dose levels of the drug were used, 1 mg/kg and 2 mg/kg. At the dimenhydrinate dosage used in the study involving radiation (1.75 mg/kg) and at the higher dosage used in the study involving rotation, there appeared to be a potentiation of the effects of radiation and rotation, respectively. Results of these studies seem to favor a model for UCS-CS mediation as being diffuse and perhaps redundant. The possibility that nausea-producing stimuli may work synergistically was also discussed. (Diss. Abstr. Int., B)

3754 DOSE–TIME RELATIONSHIPS FOR SKIN REACTIONS AND STRUCTURAL DAMAGE IN RAT FEED EXPOSED TO 250-kVp X RAYS. Moulder, J. E.; Fischer, J. J.; Casey, B. A. (Yale Univ., New Haven). Radiology; 115: No. 2, 465-470(May 1975).

The effects of fractionated irradiation on the feet of rats were the subject of a time-dose study. The doses required to produce various levels of early skin damage, late skin damage, and late structural damage were determined for single doses and for treatments employing three fractions per week and lasting up to 50 days. The data did not follow the relationship first proposed by Strandqvist, in which dose is proportional to time; rather, when the normal-tissue reactions were plotted on a linear-coordinate graph, they formed parallel time-dose iso-effect curves with distinct positive curvatures. (auth)

3755 INHIBITION OF ANTIBODY FORMATION AFTER LOCAL FRACTIONATED IRRADIATION. Brusenina, N. D.; Kartasheva, A. L.; Borovskii, E. V. (Moscow Medical Stomatological Inst.). Med. Radiol.; 22: No. 3, 55-58(Mar 1975). (In Russian).

The immunological condition of the organism at various periods after fractionated γ irradiation of the lower jaw of animals in a total dose of 3000 rad is discussed. Twenty-one sexually mature dogs were subjected to a study. Long-term inhibition of the function of antibody formation, decrease of the relative content of γ-globulin fraction of the blood serum proteins, and intensity of the plasmacytic reaction in the lymph nodes were observed during the first 3 to 6 months from the moment of termination of the course of fractionated γ irradiation. (auth)

3756 ENDOMETRIOSIS IN FOUR IRRADIATED RHESUS MONKEYS. Splitter, G. A.; Kirk, J. H.; MacKenzie, W. F.; Rawlings, C. A. (School of Aerospace Medicine, Brooks Air Force Base, TX). Vet. Pathol.; 9: No. 4, 249-262(1972).

Four Rhesus monkeys irradiated at 1 year of age developed extensive endometriosis of the pelvic and peritoneal cavities 7 years later. Endometriosis was characterized by aggressive viable nonanaplastic endometrial epithelial cells in ectopic sites throughout the genital organs. Theories of pathogenesis for man may not be valid for nonhuman primates. Retrograde flow of endometrial fragments via the oviducts may be the source of the extrauterine lesions since in monkeys 1, 2, and 4 the ovaries were in the main extrauterine masses. Whether the extrauterine endometrium is metaplastic or metastatic, there is little doubt that endometriosis is linked to the cyclic hormones of the female's reproductive cycle. The cases reported occurred at 8 years of age, and the deaths may illustrate shortening of life as a latent effect of irradiation. (auth)

3757 RADIATSIONNAYA BIOKHIMIYA. (Radiation Biochemistry). Pomantsena, E. F. (ed.). Sovremennye Problemy Radiobiologii, Tom IV. Moscow; Atomizdat (1975). 285p.

Separate abstracts were prepared for the twelve chapters of the book. (HLW)

For abstracts of individual chapters see: 3655–3661, and 3758–3762.

3758 RADIATION IMPAIRMENT OF THE METABOLISM OF LIPIDS OF CELLULAR MEMBRANE FORMATIONS. Kolomiitseva, I. K.; Vasil'ev, A. V. pp 149-163 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian).

A critical review is presented of the radiation impairment of membrane lipids. The topics discussed are singularities of the metabolism of lipids during radiation injury, biosynthesis of phospholipids and cholesterol in the liver of irradiated rats, radiation impairment of the metabolism of lipids of subcellular structures, comparison of the exchange of phosphate and acyl groups of phospholipids, and regularities in the transfer of phospholipids between subcellular structures of liver cells in the rat. (82 references). (JSR)

3759 PROBLEM OF RADIOTOXINS. Kuzin, A. M. pp 192-218 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian)

The problem of radiotoxins can be considered from four aspects at the current time. The first is the formation of radiotoxins during the irradiation of the food and food products of the agricultural and animal industries, their nature, biological properties, and permissible or limited use of radiation preservation of food. The second is the role of radiotoxins in the formation of radiation effects during radiation injury of organisms and animal and vegetable tissue. The third is the study of radiotoxins as growth inhibitors and mutagens and materials changing the properties of biomembranes. The fourth is the possible role of radiotoxins in the earth's biosphere. Studies in each of these areas are critically reviewed. (101 references) (JSR)

3760 ROLE OF NEUROENDOCRINE SYSTEMS IN METABOLIC SHIFTS UNDER THE EFFECTS OF IONIZING RADIATION. Cherkasova, L. S. pp 219-249 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian)

Studies made on the changes of neuroendocrine systems under the effects of radiation are critically reviewed. The endocrine structures considered are the hypothalamus, pituitary gland, pituitary gland-adrenal system, catecholamines, insular portion of pancreatic iron, and thyroid iron. (90 references) (JSR)

3761 METABOLIC FREE RADICAL IN TISSUES OF ANIMALS UNDER NORMAL CONDITIONS AND DURING IRRADIATION. Kolomiitseva, I. K. pp 250-260 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian)

A critical review is presented of studies on free radicals in dry tissues from normal animals and after irradiation and on metabolic free radicals in moist objects during in vivo and in vitro irradiation. (45 references) (JSR)

3762 ROLE OF ENDOGENOUS AMINES AND PEROXIDES IN THE PROTECTIVE MECHANISM OF RADIOPROTECTIVE AGENTS. Goncharenko, E. N.; Kudryashov, Yu. B. pp 269-285 of Radiatsionnaya Biokhimiya. Pomantsena, E. F. (ed.). Moscow; Atomizdat (1975). (In Russian)

Experimental verification is given of the previously proposed mechanism of the radioprophylactic effect. The mechanism proposed was based on the assumption of the formation in the animal organism of a background of increased radioresistance as a result of the mobilization of the protective resources of the organism. The amount of serotonin, dopamine, histamine, and lipid radiosensitizers in the tissues and organs of rats was

determined before and after administration of cystamine, MEA, AET, alanine, serine, histamine, adrenaline, and MOT of varying effectiveness. The results are given in tabular and graphic form and confirm the original hypothesis. (JSR)

3763 DOSE DISTRIBUTION AND NEOPLASIA IN THE LUNG FOLLOWING INTRATRACHEAL INSTILLATION OF $^{239}PuO_2$ AND ASBESTOS. Sanders, C. L. (Battelle Pacific Northwest Labs., Richland, WA). Health Phys.; 28: No. 4, 383-386(Apr 1975).

The influence of dose distribution on pulmonary carcinogenesis was examined in four groups of rats given an intratracheal instillation of either saline, 0.9 mg asbestos, 30 nCi $^{239}PuO_2$, or mixed 0.9 mg asbestos + 50 nCi $^{239}PuO_2$ particles. The pulmonary retention half-time for ^{239}Pu was about 200 days in rats given PuO_2 and 450 days in rats given PuO_2 + asbestos; the cumulative radiation dose to lung at 2 yr after instillation being 400 and 1200 rads, respectively. PuO_2 particles were concentrated with asbestos-induced scars in peribronchiolar regions of the lung as compared to a more homogeneous distribution when PuO_2 was given alone. No differences in mortality were seen between any of the groups. At 2 yr after instillation, the incidences of pulmonary carcinoma were none in rats given saline, 4.5% in rats given asbestos, 32% in rats given PuO_2 and 21% in rats given PuO_2 + asbestos. It was concluded that immobilization and concentration of α emitters in the lung reduces their carcinogenic effects. (auth)

3764 RESPONSE OF THE ^{59}Fe UPTAKE SYSTEM IN RAT FEMORAL MARROW EXPOSED TO VARIOUS X-RAY ENERGIES. Maillie, H. D.; Lopez, O. (Rochester Univ., NY). Health Phys.; 28: No. 4, 405-409(Apr 1975).

Rats were given whole-body exposures to four incident x-ray energies. The influence of dose from each of these energies upon iron uptake in the center of the femoral shaft-marrow was noted. Uptake ratios showed a change with increasing dose which may be expressed by the formula: $U_T = 0.87 \exp [-(0.693/D_{50}) \times D] + 0.13$. It was found that the D_{50} was essentially the same (regardless of the incident photon energy) and had a pooled value of 75 ± 9 rad. A comparison made with a previous spinal column study showed a D_{50} value of 71 ± 7 rad. Not only was there no difference in response with the differing photon energies studied, but it seems likely that femoral marrow may be used as a calibration for other marrow sites - particaularly those which do not lend themselves to the usual dosimetry techniques. (auth)

3765 INHIBITION OF HAEMOPOIETIC STEM CELLS BY SYNGENEIC LYMPHOCYTES TREATED WITH ANTILYMPHOCYTE SERUM. Kaulen, D. R.; Golovanova, T. A., Pyatikhina, D. P.; Khorobrikh, V. V. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow). Folia Biol. (Prague); 21: No. 2, 95-102(1975).

Some aspects of the mechanisms by which antilymphocyte serum, its globulin fraction, or phytohaemagglutinin act to reduce the stem cell content of murine hemopoietic tissues were studied, using the method of clonal proliferation of stem cells in the spleens of lethally irradiated (830R) mice. The transplants were treated in vitro with ALS, ALG, or PHA for 30 min. at 37°C. Direct treatment of spleen or bone marrow cells with ALS of PHA resulted in pronounced inhibition of the colony-forming capacity of hemopoietic tissues in syngeneic irradiated recipients. The degree of inhibition was dependent on the concentration of ALS of PHA. It was found that the inhibition of CFC with ALS was mediated by lymphoid cells: bone marrow CFC were reduced after 30-min. incubation at 37°C with syngeneic lymph node or thymus cells pretreated with ALG and washed free of its excess. It was further demonstrated that ALG-treated thymocytes released, upon 30-min. incubation at 37°C, some material capable of inhibiting bone marrow CFC. No release was observed with PHA-treated thymocytes. Some properties of the active supernatants are described and it is suggested to designate the observed inhibitory activity as Stem-cell Inhibitory Factor. (auth)

3766 ROLE OF HAEMOPOIETIC TISSUE IN INTERSTRAIN DIFFERENCE IN RADIOSENSITIVITY OF MICE. Vacek, A.; Rakova, A.; Rotkovska, D. (Inst. of Biophysics, Brno). Folia Biol. (Prague); 21: No. 2, 103-110(1975).

Mice of three different strains were classified according to the percentage of survival after a whole-body exposure of 600R as radioresistant (strain C57BL/10), radiosensitive (strain BALB/c), and intermediate (strain BFU). Hemopoietic recovery after a whole-body exposure of 200R was followed in the three groups. It was found that the radiosensitivity of bone marrow and spleen hemopoietic stem cells was equal in all the mouse strains tested. The extent of radiation damage to hemopoiesis, assessed by the changes in nucleated cell counts in bone marrow and spleen, as well as by bone marrow and spleen ^{59}Fe uptake, was smaller and the rate of recovery higher in strain C57BL/10 than in strains BALB/c or BFU. An analogical difference among the strains was also observed during realimentation in the recovery of bone marrow and spleen hemopoiesis inhibited by fasting. The role of the capacity of hemopoietic cell populations to repair the induced hemopoietic damage is discussed and its decrease in BALB/c mice is held responsible for their higher radiosensitivity. (auth)

3767 DETERMINATION OF PROTEIN LEVELS BY QUANTITATIVE IMMUNOELECTROPHORESIS IN RATS SUBJECTED TO CONTINUOUS IRRADIATION. Chlebovska, K.; Milar, O.; Bernasovsky, I.; Praslicka, M. (Univ., Kosice, Czech.). Folia Biol. (Prague); 21: No. 2, 122-126(1975).

Changes in the concentration of some serum proteins are determined by quantitative two-dimensional immunoelectrophoresis in rats subjected to continuous irradiation with 400 R/day for 11 days. At this dose rate albumin levels were decreased by 36% and IgG levels by 70% in comparison with the control (C2) values. The concentration of haptoglobin, hemopexin and ceruloplasmin was increased by 75 to 140% on day 10 as compared with the control (C2) values. (auth)

3768 ANALYSIS OF PROGRAMMED GENE ACTION BY MEANS OF RADIATION CHIMAERAS. Boubelik, M.; Lengerova, A.; Zeleny, V. (Inst. of Experimental Biology and Genetics, Prague). Folia Biol. (Prague); 21: No. 2, 81-86(1975).

Agglutinability by H-2 antisera of neonatal erythrocytes appears early in some mouse strains (such as C57BL/10) and late in others (A, CBA, etc). This might be due to interstrain differences of the postulated temporal genes controlling in this case the developmental expression of H-2 gene products. A similar effect might be simulated by interstrain variation in neonatal size of erythrocytes (possibly reflecting their stage of maturation from the generally larger blasts) which could indirectly affect agglutinability through a different density of H-2 sites on the cell surface. Such correlation was, however, not found in this study. A possible involvement of an extracellular control mechanism was also ruled out by demonstrating that in allogeneic radiation chimeras created reciprocally from late and early strain mice (used as irradiated recipients and donors of curative cell inocula) the appearance of donor-specific H-2 agglutinability conforms to the donor's timing type being unaffected by the contrasting host's environment. The delayed agglutinability in a late strain was further shown to concern not only neonatal erythrocytes, but also those recruited from stem cells in adult bone marrow. Finally, two strains (C67BL/10 and CBA) classified as, respectively, early and late by H-2 agglutinability were typed similarly on the basis of the time course of ^{59}Fe-incorporation rate/mg. spleen in newly formed syngeneic radiation chimeras. The question whether this coincidence is due to chance or to H-2 linkage of a common or rather separate control mechanisms is discussed. (auth)

3769 QUANTITATIVE MICROSPECTROPHOTOMETRIC STUDIES ON THE NUCLEIC ACID CONTENTS OF NEURAL CELLS OF IRRADIATED AND WITH RESERPINE PRETREATED RATS. Hariri, N. I.; Topcuoglu, N.; Aksu, Y.; Havens, V. (Ege Universitesi, Izmir, Turkey). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 222-224(Apr 1975).

A study carried out to detect the quantitative alterations of DNA and RNA content of neurons and neuroglia in ten rats is described. Four of the rats were irradiated with x rays, a further three were pretreated with reserpine before irradiation and three were used as controls. Ten neurons and glial cells of the pallidum of each set were measured and a completely random test was carried out for the analysis of extinction data of neuronal nuclei, nucleoli, cytoplasm, and glial cells. Results are presented that show varying responses of the neuronal and glial cells to radiation and reserpine treatments. (UK)

3770 COMPARISON OF SKIN RESPONSES OF MICE AFTER SINGLE OR FRACTIONATED EXPOSURE TO CYCLOTRON-ACCELERATED HELIUM IONS AND 230 kV X IRRADIATION. Leith, J. T.; Schilling, W. A.; Lyman, J. T.; Howard, J. (Univ. of California, Berkeley). Radiat. Res.; 62: No. 2, 195-215(May 1975).

Mouse skin was irradiated with either cyclotron-accelerated helium ions or 230 kV x rays. Single-dose exposures to helium ions were performed in the plateau region and in the Bragg peak region of ionization after modification of the peak region by insertion of a moving copper ridge filter into the beam path (spread-out Bragg peak). The degree of recovery occurring between equal fractions of helium ions (using the spread-out Bragg peak) given with an interval of 24 hr was compared to recovery after x irradiation also with a 24-hr interval. Single doses of helium ions in the plateau portion of ionization gave skin responses not significantly different from x-ray responses, as determined by comparing average skin

responses over the period of 8 to 30 days postirradiation. Helium ion irradiations in the spread-out Bragg peak region of ionization yielded a relative biological effectiveness of about 1.3 as compared to that yielded by x irradiation. Recovery after helium ion irradiation in the Bragg peak region was not statistically different from x-ray recovery values, which were about 500 rads. Evaluation of late skin reactions (95 to 105 days postirradiation) indicated that the late RBE of spread-out Bragg peak helium ions was 1 to 1.2 and the RBE of plateau helium ions was 1.0. Comparison of split doses of spread-out Bragg peak helium ions and x rays showed that the skin reaction dose responses were not significantly different at 95 to 105 days postirradiation, when RBE for single doses was allowed for. (auth)

3771 CHANGES IN THE LIPID FRACTION OF EEL GILLS AFTER IONIZING IRRADIATION IN VIVO AND A SHIFT FROM FRESH TO SEA WATER. Hansen, H. J. M. (Danish Atomic Energy Commission, Risoe, Denmark). Radiat. Res.; 62: No. 2, 216-224(May 1975).

Sixteen eels were adapted to tap water for a week. Then eight of them were irradiated with 1000 R gamma radiation and four of the irradiated group and four of the nonirradiated control group were transferred to seawater. The rest remained in tap water. Three days later all were incubated with ^{14}C-labeled acetate and ^{32}P-labeled phosphate added to the water in the aquariums. Lipids from the gills were separated by tlc and the individual fatty acids were assayed by paper chromatography. Results showed an enhanced incorporation of ^{14}C activity into sterol esters in seawater. This was further intensified by gamma irradiation. Similarly, gamma irradiation intensified a relatively enhanced incorporation in seawater of ^{32}P activity into lecithin, and there was a relatively increased synthesis of certain ^{14}C-labeled unsaturated fatty acids (mainly $C_{18:1}$) in the gills of animals that had both been irradiated and transferred to seawater. By measuring lipid biosynthesis in gill tissue it was thus possible to show an interaction between the effect of ionizing irradiation and the salinity of the environment, in agreement with previous biological findings. (auth)

3772 RESPONSES OF THE MOUSE TO MICROWAVE RADIATION DURING ESTROUS CYCLE AND PREGNANCY. Rugh, R.; Ginns, E. I.; Ho, H. S.; Leach, W. M. (Dept. of Health, Education, and Welfare, Rockville, MD). Radiat. Res.; 62: No. 2, 225-241 (May 1975).

A new facility for microwave irradiation of mice that will provide reproducible dosimetry is described. The waveguide used provided the integral dose rate to experimental animals under stable and controlled environmental conditions of relative humidity and temperature, variables which have been found to be critical in microwave studies. In terms of average absorbed lethal dose, the female mouse was found to be more sensitive to microwave irradiation during estrus than during diestrus. Teratogenesis (e.g., exencephalies) after sublethal irradiation of pregnant mice at 8 gestation days resulted from absorbed doses within the range of 3 to 8 calories per gram of body weight, and was never an all-or-none response. The incidence and variety of effects produced (hemorrhage, resorption, stunting, and fetal death) indicate that the cause and effect relationships are neither linear nor well enough established and understood to permit prediction of the biological effects either in the mouse of other species. As the absorbed dose of radiant energy is increased to the 8-day pregnant mouse, the probability of it producing at least one exencephaly is likewise increased. Nevertheless, the determination of the absorbed dose of microwave energy in each mouse is one step closer to determining the precise absorbed-dose-effect relationship for microwave exposures. A total of 1096 mice were exposed to microwave radiation and separately monitored to gather the related data. (auth)

3773 ASEPTIC ENDOTOXEMIA IN RADIATION INJURY AND GRAFT-VS-HOST DISEASE. Walker, R. I.; Ledney, G. D.; Galley, C. B. (Armed Forces Radiobiology Research Inst., Bethesda, MD). Radiat. Res.; 62: No. 2, 242-249(May 1975).

Endotoxemia of intestinal origin may occur in individuals subjected to high doses of either ionizing radiation or radiation followed by transplants of foreign immune competent cells capable of producing graft-vs-host disease (GVHD). The results of the following studies support the contention that aseptic endotoxemia may be due to failure to clear endotoxin from the circulation and detoxify it in the liver of immunosuppressed animals. To determine if intestinal endotoxin may contribute to pathogenesis in immunosuppressed individuals, B6CBF1 mice were exposed to 850 rads x rays, and transplanted with allogeneic CBA spleen cells. Aseptic endotoxemia, detected with the limulus lysate assay, was found at 24 and 72 hr postirradiation in livers of mice irradiated only. Contrary to this, endotoxin was not found in mice on days 5, 7, and 8 after x irradiation. Mice died between 11 and 13 days after radiation exposure, at which time bacteria and endotoxin were detected in the liver. In contrast, endotoxin was demonstrable on days 1 and 5 in mice undergoing GVHD. Mice receiving allogeneic grafts after 850 rads survived only 7 days, while gram-negative organisms were detected frequently in liver fragments from 24 hr to day 7. By day 4, hepatosplenic localization of iv-injected (^{51}Cr)endotoxin was reduced 50 percent in these animals and 2- to 3-fold increases in endotoxin levels were found in lung, kidney, heart, and brain. Hepatosplenic endotoxin concentration was not altered dramatically in mice receiving radiation alone. Endotoxin levels in other organs were not altered. Thus, endotoxin is present in detectable amounts in the liver of immunosuppressed mice. (auth)

3774 EFFECT OF PHOTON (^{60}Co) IRRADIATION ON RABBIT CHOROIDAL MAST CELLS. Price, J. (Univ. of California, Berkeley). Radiat. Res.; 62: No. 2, 258-266(May 1975).

The number of choroidal mast cells in the uvea of the albino rabbit was decreased at 3 days after a single dose of ^{60}Co gamma radiation ranging from 2,400 to 19,400 R. A return to normal levels generally occurred within 8 days postirradiation. This decrease in the number of mast cells could be a direct effect on the cell or an effect on their cytoplasmic granules. 850 R given abdominally, with the head shielded, did not change the mast cell population and indicates an indirect effect was not the cause of the observed fall in number when their heads were irradiated. A dose-response relationship was not found. A dose as high as 19,000 R did not change this population remarkably; therefore, this cell is very radioresistant. (auth)

3775 EFFECT OF S-2-(3-AMINOPROPYLAMINO)ETHYL-PHOSPHOROTHIOIC ACID (WR-2721) ON INTESTINAL CRYPT SURVIVAL. I. 4 MeV X Rays. Sigdestad, C. P.; Connor, A. M.; Scott, R. M. (Univ. of Louisville, KY). Radiat. Res.; 62: No. 2, 267-275(May 1975).

The effectiveness of S-2-(3-aminopropylamino)ethylphosphorothiotic acid (WR-2721) to protect against 4 MeV x irradiation was tested on the intestinal epithelium of the mouse. The agent was found to be most effective when injected 15 min prior to irradiation. The protective agent increased the LD/sub 50(6)/ by 816 rads. This resulted in a dose-modification factor of 1.64. WR-2721 did not modify the inherent radiosensitivity of the intestinal crypts, but displaced the curve to the right by 758 rads. The total and per crypt cellularity in protected and unprotected mice exposed to x irradiation is described. (auth)

3776 X-RAY SENSITIVITY OF THE PREIMPLANTATION MOUSE EMBRYO IN VITRO. Goldstein, L. S.; Spindle, A. I.; Pedersen, R. A. (Univ of California, San Francisco). Radiat. Res.; 62: No. 2, 276-287(May 1975).

The radiosensitivity of preimplantation mouse embryos in vitro was analyzed by culturing them to early postimplantation stages after irradiation. Embryos were removed from the oviducts at the 2-cell stage and cultured to the 4-cell, 8-cell, morula, or blastocyst stage for irradiation. After further culture, embryos were scored for blastocyst formation, hatching, trophoblast outgrowth, and inner cell mass (ICM) growth. Probit analysis of dose response for blastulation indicated that radiosensitivity increased between the 2-cell and 4-cell stages and decreased at the 8-cell stage. Irradiation of morulae did not prevent blastulation but impaired hatching (ED_{50} equals 339 +- 39 rads), trophoblast outgrowth (ED_{50} equals 269 +- 21 rads), and particularly ICM growth (ED_{50} equals 109 +- 17 rads). After irradiation at the blastocyst stage, embryos were much more capable of hatching and trophoblast outgrowth (ED_{50} greater than 1600 rads) than when irradiated at other stages but were still incapable of ICM growth (ED_{50} equals 180 rads). Developmental failure of embryos irradiated at the 2-cell, 4-cell, and 8-cell stages was a combination of preimplantation and postimplantation deaths, whereas failure of embryos irradiated at the morula and blastocyst stages occurred predominantly postimplantation. The different sensitivities of trophoblast and ICM are consistent with the unique growth patterns of these two tissues. (auth)

3777 LIGHT MICROSCOPIC DISTRIBUTION AND ELECTRON MICROSCOPIC IDENTIFICATION OF SEVERELY DAMAGED CELLS IN X-IRRADIATED ORAL EPITHELIUM IN RAT. Liu, H. M.; Meyer, J.; Waterhouse, J. P. (Univ. of Illinois, Chicago). Radiat. Res.; 62: No. 2, 288-298(May 1975).

After x irradiation with a single dose of 5000 R to the lower lip of shielded rats, the responses of the epithelium of the mucosa were studied at 2, 6, 26, and 50 hr by light and electron microscopy. Light microscopy showed sharp contrasts in the intensity of staining among the irradiated basal cells and the presence of focally distributed dark cells. These were identified in the electron microscope as degenerating cells with condensed nuclear and cytoplasmic contents and degenerate organelles. Quantitative analysis of the pattern of distribution of dark cells revealed a marked increase in over-all frequency, pairing, and formation of larger

clusters by 50 hr. At this time dark cells were 11.6 percent of the total number of the basal cells and the largest cluster consisted of 12 adjacent cells. The distribution of dark cells at 50 hr fitted the negative binomial distribution (goodness of fit, chi^2 equals 5.03, p equals 0.185) and showed significant clustering. The mechanism of pair and cluster formation is discussed. (auth)

3778 EFFECT OF CADMIUM CHLORIDE ON THE RADIATION RESPONSE OF THE ADULT RAT. Lappenbusch, W. L. (Environmental Protection Agency, Seattle); Gile, J. D. Radiat. Res.; 62: No. 2, 313-322(May 1975).

Adult male rats were injected twice weekly for 30 days with 0, 12.5, 62.5, 125, or 250 mu g $CdCl_2$ solution, then (1) maintained another 30 days (Day 60) without further treatment if used for the $CdCl_2$ mortality study, or (2) administered x rays if used for either the radiosensitivity study or the investigations concerned with the effect of the co-insults on the blood picture (number of circulating RBC and WBC, including differentials). A tissue accumulation and distribution study showed that cadmium is retained in the liver and kidney, followed by lesser concentrations in the spleen, heart, intestine, lung, stomach, muscle, blood, and brain. Tissue accumulation of Cd was linearly related to $CdCl_2$ administered. Concentrations of 125 mu g $CdCl_2$ solution or less caused no mortality while the higher concentration killed 20 percent. (auth)

3779 SYSTEMIC PROTECTION AGAINST RADIATION. I. Effect of an Elemental Diet on Hematopoietic and Immunologic Systems in the Rat. Pageau, R.; Lallier, R.; Bounous, G. (Univ., Sherbrooke, Quebec). Radiat. Res.; 62: No. 2, 357-363(May 1975).

Rats were fed the Mead-Johnson elemental diet 3200-BD or the normal laboratory pellet food. The former group was found more resistant to a 700-rad total-body exposure of ^{60}Co gamma radiation. In these animals, [^{3}H]Tdr incorporation was higher in the thymus, spleen, and bone marrow. They could also respond better to an antigenic stimulation by producing a larger amount of antibody. The radioprotective action of the diet might be explained in terms of an enhanced cellular proliferation of the hematopoietic tissues. Finally, a relation seems to exist between this enhancement and a more efficient immune response in diet-fed animals. (auth)

3780 SUPEROVULATION, COMPENSATORY OVULATION, AND UNILATERAL INHIBITION OF OVULATION BY SELECTIVE OVARIAN X IRRADIATION OF IMMATURE RATS: POSSIBLE MODES OF ACTION. Feingold, S. M.; Hahn, E. W. (Sloan-Kettering Cancer Center, New York). Radiat. Res.; 62: No. 2, 374-378(May 1975).

The gonadotropin-primed immature rat was evaluated as a possible model system for studying x irradiation effects on ovulation produced in mature rats. These effects include superovulation in whole-body irradiated animals and selective inhibition of ovulation when only one ovary is irradiated. This model, if suitable, would allow study of the hormonal factors involved in producing these ovulatory changes. BLU-LE females (26 days old) were given 4 IU of PMS and 15 IU of HCG to induce ovulation, and one or both ovaries were exposed to 400 R of x irradiation. Other groups were unilaterally ovariectomized after x ray. We were able to mimic in immature rats the array of x-ray-induced ovulatory effects observed in adult rats, and conclude that this system is a suitable model system for studying the mechanisms of action utilizing controlled amounts of exogenous gonadotropins. (auth)

3781 POST-IRRADIATION PROLIFERATION KINETICS OF A SERIALLY TRANSPLANTED MURINE ADENOCARCINOMA. von Szczepanski, L.; Trott, K. R. (Gesellschaft fuer Strohlen- und Umweltforschung mbH, Munich). Brit. J. Radiol.; 48: No. 567, 200-208(Mar 1975).

The proliferation kinetics of the transplanted adenocarcinoma 284 of C3H mice from the first to the sixth day after 600 R and from the first to the eighth day after 1,200 R has been studied by repeated labelling of the tumor cells in vivo with ^{3}H-thymidine and measurement of the labelling index and the percentage of labelled mitotic cells. The time course of the post-irradiation synchronization was followed during the first day. Later, the mean generation times of the tumor cells were usually prolonged and the spread of the generation times increased. Three to four days after irradiation, the tumor increased its growth fraction to twice the normal value by triggering resting cells (G_0 cells) into cycle. (auth)

3782 LUNG CANCER INDUCED IN HAMSTERS BY LOW DOSES OF ALPHA RADIATION FROM ^{210}Po. Little, J. B.; Kennedy, A. R.; McGandy, R. B. (Harvard University School of Public Health, Boston). Science; 188: No. 4189, 737-738 (16 May 1975).

Lung cancers have been induced in 9 to 53 percent of hamsters given multiple intratracheal instillations of polonium-210 in amounts yielding lifetime exposures of 15 to 300 rads to the lungs. Cigarette smokers have previously been estimated to receive 20 rads to areas of the bronchial epithelium from deposited polonium-210. This finding thus supports the hypothesis that alpha radiation resulting from the polonium-210 or lead-210 present in cigarette smoke may be a significant causative factor in human lung cancer. (auth)

3783 CORRECTION OF DEVELOPMENTAL ABNORMALITIES RESULTING FROM LOCALIZED ULTRAVIOLET IRRADIATION OF AN AMPHIBIAN EGG. Malacinski, G. M.; Allis, C. D.; Chung, H. M. (Indiana Univ., Bloomington). J. Exp. Zool.; 189: No. 2, 249-254(Aug 1974).

Ultraviolet irradiation of the vegetal hemisphere of uncleaved R. pipiens eggs results in the development of characteristic defects in neural morphogenesis. These defects can be prevented from occurring if uv-irradiated embryos are either incubated at low temperature (cryoreversion), microinjected with oocyte homogenate, or surgically manipulated by replacing their dorsal lip with the lip of a normal (non uv-irradiated) embryo at the time of gastrulation. (auth)

3784 AUTOMATIC RECOGNITION OF IRRADIATED CHROMOSOMES. Aggarwal, R. K.; Fu, K. S. (Purdue Univ., West Lafayette, IN). J. Histochem. Cytochem.; 22: No. 7, 561-568(Jul 1974).

There are essentially three types of aberrations of irradiated chromosomes in a mitotic cell: namely, fragments, rings, and dicentrics, which are resulted from breakages and exchanges of chromatids. The occurrence of any of these aberrations is considered to be a very useful indicator of radiation damage at cell level. The large volume of tests required for monitoring health-related radiation damage necessitates an automated system for recognition of these aberrant chromosomes. Such a system, using a cutoff level independent skeletonization approach, has been developed and is discussed. The test results on 15 abnormal cells are also presented. (auth)

3785 SPARSE SEEDING OF BONE MARROW AND THYMUS IN RADIATION CHIMAERAS. Wallis, V. J.; Leuchars, E.; Chwalinski, S.; Davies, A. J. S. (Chester Beatty Research Inst. London). Transplantation; 19: No. 1, 2-11(Jan 1975).

The repopulation of the thymus was studied in mice after a potentially lethal dose of irradiation and injection of different numbers of syngeneic but chromosomally distinguishable bone marrow cells. The more bone marrow cells were injected, the earlier was the changeover from dividing host cells to dividing donor cells observed. At both 30 and 60 days after irradiation, the number of donor-derived T cells in the peripheral blood responding to phytohemagglutinin was directly proportional to the number of donor bone bone marrow cells injected, but the number of host-derived T cells was inversely proportional. Experiments in which mixtures of two syngeneic chromosomally distinguishable haematopoietic cell populations were injected after irradiation suggested that relatively small numbers of haematopoietic cells can be responsible for repopulating a single femur. Analysis of the thymus showed that the dividing cell populations within the thymus can also derive from very few precursor cells, possibly as few as one or two. (auth)

3786 CHARACTERISTICS OF HISTOCOMPATIBILITY BARRIERS IN CONGENIC STRAINS OF MICE. III. Passive Enhancement of Skin Allografts in X-Irradiated Hosts. Cantrell, J. L.; Kaliss, N.; Hildemann, W. H. (Jackson Lab., Bar Harbor, ME). Transplantation; 19: No. 2, 95-101(Feb 1975).

Passive immunological enhancement of skin allografts was investigated in three donor-host combinations of congenic mice disparate at non-H-2 loci. Serum against the graft donor was derived from mice that had received donor strain lymphoid cells as neonates, and thereby were rendered specifically tolerant of a skin allograft. We refer to this serum as "allograft-tolerant" serum. Each strain combination was chosen to provide only two non-H-2 histoincompatibilities present in the donor and absent in the host. The differences are categorized as immunogenetically strong, moderate, or weak, on the basis of skin allograft survival times. With passively administered allograft-tolerant serum, significantly prolonged graft survivals were noted for the weakest combination only. Combined treatment with sublethal x-irradiation and allograft-tolerant serum significantly prolonged graft survival in both the moderate and weak combinations, with the largest effect present in the weakest disparity. A hyperimmune alloantiserum (produced in adults) directed against the graft donor prolonged allograft survival in the strongest disparity when given in combination with irradiation. In this combination, graft survival time was increased in hosts exposed to x-ray alone, but joint treatment with x-ray and the alloantiserum gave the largest increment. In con-

trast, combined treatment with the serum and an antithymocyte alloantiserum did not affect graft survival times. Treatment with both radiation and antithymocyte serum did not prolong graft survival beyond that in mice given only x-radiation. Immunological enhancement with central inhibition is assumed as the mechanism underlying prolonged graft survival, and it is suggested that a population of thymus-derived killer cells, sensitive to x-irradiation, is required for normal graft rejection. (auth)

3787 EVIDENCE OF CYTOTOXIC T AND B IMMUNOBLASTS IN THE THORACIC DUCT OF RATS BEARING TUMOR GRAFTS. Denham, S.; Wrathmell, A. B.; Alexander, P. (Chester Beatty Research Inst. Sutton, Eng.). Transplantation; 19: No. 2, 102-114 (Feb 1975).

Wistar rats were immunized with allogeneic or xenogeneic tumour before collection of their thoracic duct lymph. Specifically cytotoxic effector cells were found in the lymph between 3 and 8 days after immunization, and their occurrence coincided with an increased number of immunoblasts in the lymphocyte population. The immune response in lymph to allogeneic cells appeared to be affected solely by radiosensitive thymus-dependent lymphocytes; no complement-depending killing was evident and cytotoxic cells failed to appear when immunized animals were deprived of thymus-dependent lymphocytes. In contrast, the response to immunization with xenogeneic cells elicited both complement-dependent and complement-independent cytotoxicity, but only the former could be detected in animals deprived of thymus-dependent lymphocytes. In normal animals and in animals deprived of thymus-dependent cells, the cytotoxic cells in the thoracic duct lymph appeared to be large lymphocytes or immunoblasts. (auth)

3788 RADIOPROTECTIVE AND TOXIC EFFECTS OF A MIXTURE OF AET AND 5-METHOXYTRYPTAMINE IN MICE. Misustova, J.; Novak, L.; Kautska, J. (Inst. of Biophysics, Brno). Physiol. Bohemoslov.; 24: No. 2, 175-182(Mar 1975).

The authors studied the radioprotective efficacy and toxicity of AET + 5-methoxytryptamine mixture and its effect on the course of respiratory exchange, using different weight ratios of the two components. The optimum was found to be 150 mg AET/kg b.w. + 25 mg 5-MOT/kg b.w. This mixture gave very good protection in the supralethal exposure range and markedly prolonged its duration. The high toxicity of this mixture was abolished by the pre-administration of glutathione. Raised and longer protection was also manifested in the course of respiratory exchange, showing that an association exists between changes in energy metabolism and raised radioresistance of the organism. (auth)

3789 HAEMOPOIETIC STEM-CELL KINETICS DURING CONTINUOUS IRRADIATION. Chu-Tse, W.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 27: No. 1, 41-50(Jan 1975).

Analysis of the kinetics of the biphasic response of haemopoietic stem cells to chronic low dose-rate irradiation indicated that a highly radiosensitive delay of entry into cell-cycle by G_0 cells may have been responsible for the initial, apparently dose-rate-independent, phase of the dose-response curve. The second component of the curve appeared to be the result of a combination of two factors: a relatively decreased differentiation demand on stem cells due to increased amplification in the transit-committed precursor cells, and a uniform shortening of the cell-cycle, including the S period, in the stem cells. (auth)

3790 SKELETAL ABNORMALITIES IN MOUSE EMBRYOS AFTER IRRADIATION OF THE SIRE. Bartsch-Sandhoff, M. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F. R. Germany). Abt. fuer Genetik). Humangenetik; 25: No. 2, 93-100(1974).

Nineteen-day-old mouse embryos sired by irradiated or control males were examined for Class 1 abnormalities of the skeleton. These results were compared to the results of similar studies on 4-week-old mice. The excess of Class 1 abnormalities over the control/gamete/R is 3.3×10^{-5} for postspermatogonial stages and 1.2×10^{-5} for spermatogonia. The frequency in postspermatogonial stages was highly significant above the controls. Because of the sampling error, it is not possible to recognize any difference between the frequency of Class 1 abnormalities found in the embryos and that reported in 4-week-old mice. However, the finding of severe abnormalities that could quite conceivably cause death and that have not been reported in 4-week-old mice strongly suggests that some of the presumed dominant mutations affecting the skeleton are lethal before 4 weeks of age. The rate determined at 4 weeks may therefore be an underestimation of the true rate of induction of dominant mutations affecting the skeleton. (auth)

3791 ULTRASTRUCTURAL CHANGES IN THE LIVER OF CHICKEN EMBRYOS AND CHICKENS TREATED WITH GAMMA RAYS. Todorov, B. (Akademiya na Selskostopanskite Nauki, Sofia (Bulgaria). Veterinaren Institut za Infektsiozni i Parazitni Bolesti). Vet. Med. Nauki (Sofia); 11: No. 9, 39-43(1974). (In Bulgarian).

The irradiation of chicken embryos and chickens with 1000 rad leads to ultrastructural changes in the mitochondria and lysosomes, varying in gravity. Mitochondria become injured as early as the first hour following treatment with γ rays, and the changes induced have proved to be more pronounced during the whole investigation period than those in the lysosomes. The changes have been most strongly manifested in 12-day-old embryos; they were most weakly manifested in 20-day-old ones. (auth)

3792 INFLUENCE OF PROTAMINE ADENOSINETRIPHOSPHATE ON THE SURVIVAL OF RATS IRRADIATED SINGLY AND LETHALLY. Pantev, T.; Bokova, N.; Nikolov, I. (Nauchno-Izsledovatelski Inst. po Radiologiya i Radiatsionna Khigiena, Sofia (Bulgaria)). Eksp. Med. Morfol.; 12: No. 4, 186-190(1973). (In Bulgarian).

Adenosine triphosphate salt of protamine, isolated from salmon, was synthesized. The antiirradiation effect of the preparation on white male rats, irradiated singly by a lethal dose of roentgen rays, was examined. As an integral criterium for protection the survival of the experimental animals was used, the mean duration of life and the coefficient of protection. The changes in the dry weight of spleen and intestines as well as the number of nuclear cells of the bone marrow were examined for evaluation of the effect of the preparation on the single syndromes of the irradiation disease. There was a considerable radioprotective effect of the protamine adenosinetriphosphate (80% survival of the experimental animals in comparison with 2% of the controls). Protamine lowered considerably its toxicity when it was administered under the form of adenosinetriphosphate. (auth)

3793 INFLUENCE OF GAMMA IRRADIATION ON THE ACTIVITY OF PEPTIDYLPEPTIDEHYDROLASES (PPH) IN TISSUES OF HEN'S EMBRYOS. Khristov, D. I.; Marinopolski, G. I. God. Sofii. Univ., Biol. Fak.; 65: No. 1, 171-181(1973). (In Bulgarian).

The influence of irradiation in vivo with different doses of gamma rays (500 and 1000 R) on the activity of peptidylpeptidehydrolases (PPH) in the liver and muscles of hen's embryos 12 and 18 days old, as well as in whole 7 days old embryos, was investigated. The following results were obtained: the PPH activity in the supernatant and mitochondrial-lysosomal tissue fraction of the irradiated embryos is higher than in controls 24 h after the irradiation; the influence of the irradiation on the PPH activity is better expressed in 7- and 12- than in 18 days old embryos; the influence of the irradiation is stronger with a dose of 1000 R; and the liver PPH activity decreases stepwise at differenct periods after the irradiation and drops under the normal level. (INIS)

3794 ON THE PROBLEM OF THE IRRADIATION RESISTANCE IN BIRDS. Dryanovski, P. (Akademiya na Selskostopanskite Nauki, Sofia (Bulgaria). Veterinaren Institut za Infektsiozni i Parazitni Bolesti). Vet. Med. Nauki (Sofia); 11: No. 4, 91-97(1974). (In Bulgarian).

The higher resistance in birds to the irradiation disease as compared to that in large and small ruminants and in the pigs is due to a number of factors, such as the lower amounts of primary lipid radiotoxins produced in the liver of birds. The amount of lymphocytes in bird is from 2.5 to 13 times higher than that in the other farm animals. One of the most important factors is the great compensatory mechanism of the nuclear erythrocytes in the peripheral blood of birds during irradiation. It consists in a sharply manifested reticulocyte crisis, the formation of binuclear erythrocytes or of couples of nuclear erythrocytes, the denucleation of erythrocytes with the production of nuclear erythrocytes or anuclear erythrocytes that have preserved their vitality and the division of anuclear erythrocytes. Also important is the greater amount of reticulocytes in the blood up to 72%, while in the blood of cattle, horses, and goats they are lacking and in the blood of sheep and pigs they range within the limits of 0.02 to 1.3%. (auth)

3795 ON THE CONTENT OF GUANOSINE AND URIDINE ACID SOLUBLE NUCLEOTIDES IN THE LIVER OF CHICKEN EMBRYOS AND CHICKENS TREATED WITH GAMMA RAYS. Dryanovski, P.; Todorov, B. Vet. Med. Nauki (Sofia); 11: No. 9, 44-49(1974). (In Bulgarian).

The total irradiation of chicken embryos and chickens with 1000 rad led to a decrease in the guanosine and uridine nucleotides. The dynamics of these changes proved different in the various age groups tested: most radiosensitive were the 12-day-old embryos, and most radioresistant were the 20-day-old ones. The decrease in the uridine nucleotides makes it reasonable to believe that the disturbances in their synthesis is one of the most essential factors

contributing to the increased permeability of the membrane structures. (auth)

3796 INFLUENCE OF GAMMA IRRADIATION ON THE CONTENT AND METABOLISM OF THE SOLUBLE LIVER PROTEINS IN HEN'S EMBRYOS. Marinopolski, G. I.; Khristov, D. I.; Simeonov, V. P. God. Sofii. Univ., Biol. Fak.; 65: No. 1, 223-231(1973). (In Bulgarian).

The influence of irradiation with different doses (500 and 1000 R) of gamma rays on the metabolism and relative content of saline-soluble liver proteins in hen's embryos at different stages of embryonal development was investigated by agar-gel electrophoresis and contact radiography. At 48 h after the irradiation, 10 mkCi of ^{35}S were inoculated in the air chamber of the eggs and the incorporation of isotope into the protein fractions was controlled at intervals of 1, 5, and 24 h after inoculation. The relative content of the fraction of soluble liver proteins with electrophoretic mobility of the sera prealbumins, albumins, and α globulins in the 12 days old embryos was higher than in control embyros. The fractions with mobility of the sera α and γ globulins tend to decrease their relative content under the influence of irradiation. These results were observed 48 h as well as 72 h after the irradiation. In 18-day-old irradiated embryos besides the fraction with α and γ globulins mobility a decreased relative content could be observed of those with prealbimins and albimin mobility. In 12-day-old embryos 1.5 h after the inoculation of the isotope in the irradiated as well as in the control embryos the highest coefficient of incorporation has the fractions with α globulins mobility (h + i + j). In the fractions with α and γ globulins mobility much less intensive incorporation was observed. In 18-day-old irradiated and control embryos an intensive incorporation was demonstrated also for the fractions with β globulins mobility. The fractions with decreased relative content as a result of the irradiation have higher coefficient of incorporation of the isotope. Fractions with increased relative content have lower coefficient of incorporation. (INIS)

3797 NEUTRON RADIOGRAPHY IN RADIOBIOLOGIC EXPERIMENTS WITH THERMAL NEUTRONS. Hermanska, J. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska); Hrdlicka, Z. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)); Prouza, Z.; Rakovic, M. (Karlova Universita, Prague (Czechoslovakia). Fakulta Vseobecneho Lekarstvi). Cas. Lek. Cesk.; 113: No. 28, 863-866(12 Jul 1974). (In Czech).

Neutron radiography is considered for use in the determination of the flux density distribution of thermal neutrons during radiobiologic irradiation of biologic objects in a nuclear reactor. (auth)

3798 HISTOLOGICAL STUDIES AFTER EXPERIMENTAL GRID IRRADIATION. V. Findings in Deep Tissue Layers. Unger, E. (Orszagos Frederic Joliot-Curie Sugarbiologiai es Sugaregeszsegugyi Kutato Intezet, Budapest (Hungary)). Strahlentherapie; 148: No. 4, 413-419(Oct 1974).

Findings are reported on deeper layers (39 to 65 mm) of rat bone marrow and Guerin tumor after slot- and grid-irradiation. As with layers closer to the surface, the histological grid-pattern corresponding to the inhomogeneous dose distribution can be well demonstrated also in the deeper layers in the majority of cases. The average width of the seriously damaged and relatively intact tissue stripes, furthermore, the ratio between the maximum damage under the slots of the grid and after irradiation in a homogeneous field correspond to the conception already proved by the earlier experiments of the author according to which the tissue volumes protected by the bars of the grid exert a protective effect on the surrounding exposed tissues. (auth)

Invertebrates

Refer also to abstract 3689.

3799 EFFECT OF X IRRADIATION ON THE FORMATION OF THE PUPARIUM IN THE FLESHFLY, SARCOPHAGA BULLATA. Sivasubramanian, P.; Ducoff, H. S.; Fraenkel, G. (Univ. of Illinois, Urbana). J. Insect Physiol.; 20: No. 7, 1303-1317 (Jul 1974).

Post-feeding, pre-critical stage larvae (36 hr before pupariation) of Sarcophaga bullata were exposed to x rays and the effects on pupariation observed. With doses ranging from 1250 to 10,000 R the prepuparial period was prolonged and the duration of this delay increased with higher doses. Doses above 2500 R inhibited the retraction of anterior segments, longitudinal contraction, and cuticular shrinkage resulting in larval-like tanned puparia. With the anterior part of the body shielded during irradiation, normal puparia were formed, but after a delay proportional to the area irradiated. Injection of β-ecdysone counteracted this delay. With the doses used, irradiation had no effect on post-critical stage larvae. This suggested that the CNS has a special mechanism which controls the neuromuscular processes of pupariation, and when this mechanism is damaged by irradiation larval-like puparia are formed. The pupariation delay was attributed to a temporary block in the synthesis, or release, or both of α-ecdysone (in whole-body or anteriorly only irradiated larvae) and its final conversion to β-ecdysone (in posteriorly only irradiated larvae). The fact that post-critical stage larvae are insensitive to irradiation suggests that the neuromuscular and neurosecretory processes which are affected by irradiation are already completed at that stage. (auth)

3800 POSSIBLE ROLE OF REPETITIOUS DNA IN RECOMBINATORY JOINING DURING CHROMOSOME REARRANGEMENT IN DROSOPHILA MELANOGASTER. Lee, C. S. (Univ. of Texas, Austin). Genetics; 79: No. 3, 467-470(Mar 1975).

It is postulated that certain repetitious DNA components play a role in the recombination processes during chromosome rearrangements. When the distribution of silver grain densities after the in situ hybridization of repetitious DNA and the distribution of chromosome breaks due to x-irradiation are compared, a strong correlation is found for the euchromatic portion of the D. melanogaster salivary X chromosome. These observations justify the postulate above that certain repetitious DNA provides homologous regions in the DNA of broken chromosome ends necessary for proper recombinatory joining. (auth)

3801 PARAMETERS OF MITOTIC RECOMBINATION IN MINUTE MUTANTS OF DROSPHILA MELANOGASTER. Ferrus, A. (CSIC, Madrid). Genetics.; 79: No. 4, 589-599(Apr 1975).

A sample of 16 Minutes, representing 12 loci distributed over all the chromosome arms and including 3 pairs of alleles and 4 deficiencies, has been studied with respect to several developmental parameters. Cell marker mutants located in most of the chromosome arms were used to assess (1) spontaneous and x-ray-induced mitotic recombination frequencies of each Minute, and (2) clone sizes of the different cell marker clones. These parameters were analyzed both in the wing disc and in the abdominal histoblasts. Whereas spontaneous frequencies are not affected by the presence of the Minutes studied, the different Minutes characteristically increase the frequency of recombination clones arising after x irradiation. The recombinant clones which are M^+/M^+ are significantly larger than clones in the same fly which retain the M^+/M condition. This is particularly striking in clones in the wing disc, slightly so in clones in tergites. The occurrence of mitotic recombination in the fourth chromosome is reported for the first time. Chaeta length and developmental delay correlates with the recombinational parameters in different ways. Possible causal interrelationships of the different traits of the Minute syndrome are discussed. (auth)

3802 ON THE IMMUNOGENIC ABILITY OF COCYSTS OF E. TENELLA IRRADIATED WITH GAMMA RAYS. Penev, P.; Stefanova, M. Vet. Sb.; 72: No. 2, 23-26(1974). (In Bulgarian).

The immunogenic abilities of E. tenella irradiated with 6000 R gamma rays were studied on chickens of two different ages. Cocysts were obtained from 15 to 20-day-old chickens infected with a culture containing 85% cocysts of E. tenella, 10% of E. necatrix, and 5% of E. mitis. Trials were conducted with chickens of two age groups, group I at 20 days and group II at 10 days. They were reared under conditions ruling out the possibility of spontaneous infections with coccidia. Each test chicken was infected per os with 50,000 sporulated cocysts of E. tenella irradiated with 6000 R gamma rays. Challenge was effected with 3 or 5 chickens on the 24th and 48th hour, on the 4th, 7th, 10th, and 22nd day of infection with irradiated cocysts. The number of cocysts in the challenge dose was thrice as large as that of the immunization one. Each challenge was accompanied with a corresponding control. Mortality of group I and group II chickens following challenge on the 24th and 48th hour after infection with irradiated cocysts was similar to that of the controls, not infected previously with irradiated cocysts. But after the challenge on the 4th, 7th, and 10th days it sharply dropped to zero for group I, and gradually diminished for group II. Results showed that E. tenella cocysts irradiated with 6000 R gamma rays lose somewhat their virulent properties but can still induce resistance against reinfection with cocysts in a dose three times as large as that of the immunization one. Coccidiosis immunity by gamma rays irradiated cocysts is not absolute unlike the statements of other authors. (INIS)

3803 THE EFFECT OF GAMMA RAYS ON THE EGGS OF RHIPICEPHALUS BURSA. Petrov, D.; Gecheva, G. Vet. Med. Nauki (Sofia); 11: No. 2, 21-25(1974). (In Bulgarian).

The effects of gamma rays on the eggs of Rhipicephalus bursa was studied using ^{60}Co as a radiation source. A total of about

2000 eggs were treated at 500, 1000, 2000, 3000, 5000, 10,000, 20,000, and 40,000 R. The percentage of larvae hatched from the eggs, the time for sucking blood, the percentage of larvae that had molted, the number of oviposed eggs, the weight of imago, and the percentage of second generation larvae were recorded. The changes in the larvae from irradiated eggs showed that treatment with gamma rays at rates of 500 to 5000 R leads to disturbances in the life cycle, and rates of 5000 R and more fully destroy the life cycle of the ticks. (auth)

3804 THE EFFECT OF GAMMA RAYS ON THE TRICHINELLAE FOUND IN THE MUSCLES. Georgieva, D. Vet. Med. Nauki (Sofia); 11: No. 2, 101-105(1974). (In Bulgarian).

The effects of gamma rays emitted by ^{60}Co at rates of from 1000 to 36,000 R on pieces of pork, sized 20 × 10 × 10 cm, were studied. The infectiveness of muscular Trichinellae treated with γ rays was tested biologically on albino mice. Intestinal Trichinellae that had developed up to sexual maturity obtained from pork, irradiated at rates above 7 kR, did not yield further generation. Rates above 9 kR inhibit the embryoformation process, and rates above 12 kR disturb the life cycle so that the muscular forms do not develop into intestinal ones. The female specimens have proved more resistance to effect of gamma rays than the male ones. (auth)

3805 THE EFFECT OF IONIZING RADIATION ON THE VIRULENCE OF BABESIA OVIS. I. Communication. Khalacheva, M. Vet. Med. Nauki (Sofia); 11: No. 9, 77-82(1974). (In Bulgarian).

Experiments were carried out to establish the effect of varying rates of gamma irradiation on the virulence of Babesia ovis. Comparison was made of the results obtained from the clinical and hematological investigations performed with experimentally infected animals. A total of 16 animals were used (two donors, two controls, and 12 tests) divided into eight groups. The virulent blood was irradiated at rates of 2000 to 30,000 R by means of an apparatus GUBE–4,000 at a 607 R/min power and a field of 400. The dose of 2000 R increased the virulence of Babesia ovis. Further rates of 5000, 7000, and 10,000 R showed no depressing effect on the virulence, however, 15,000, 20,000, and 30,000 R decreased the virulence of the parasite without killing it. The changes in the hemoglobin content and the erythrocyte and leucocyte counts depend on the course of disease and the rate of irradiation. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 3063, 3705, 3721, and 3735.

3806 (COO-3382-14(Vol.2), pp IV,1-IV,34) NON-OCCUPATIONAL RADIATION EXPOSURES FROM ^{222}Rn AND DAUGHTERS TO RESIDENTS OF GRAND JUNCTION, COLORADO. Spitz, H. B.; Cohen, N.; Wrenn, M. E. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

Six individuals from Grand Junction, Colorado were examined for ^{210}Pb body burdens as a result of living in homes where concentrations of ^{222}Rn were elevated due to the presence of uranium mill tailings beneath the building foundation. In vivo detection for ^{210}Pb using three NaI–CsI (Tl) thin crystals in the standard NYU head geometry identified two persons with estimated body burdens above 1.1 nCi. Bioassay for ^{210}Pb was also performed to compare with the in vivo analysis and to further substantiate the relationship between ^{210}Pb in bone, blood, and urine. Estimates of exposure in cumulative working level months (CWLM), range 85 to 566 CWLM, were used to calculate expected body burdens of ^{210}Pb. The NYU continuous readout radon monitor provided diurnal measurements of ^{222}Rn in the homes of the volunteer subjects so that, considering assumptions about ventilation and residence times, actual exposures could be determined. (auth)

3807 (ORNL-TM-4663) CONDOS: A MODEL AND COMPUTER CODE TO ESTIMATE POPULATION AND INDIVIDUAL RADIATION DOSES TO MAN FROM THE DISTRIBUTION, USE, AND DISPOSAL OF CONSUMER PRODUCTS THAT CONTAIN RADIOACTIVE MATERIALS. O'Donnell, F. R.; McKay, L. R.; Burke, O. W.; Clark, F. H. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 99p. Dep. NTIS $5.45.

A model and computer code (CONDOS) are described that estimate radiation doses to man from distribution, use, and disposal of a variety of consumer products that contain radioactive materials. CONDOS utilizes a generalized format in which the life span of a consumer product is divided into five main stages (distribution, transport, use, disposal, and emergencies) that require descriptions of the activities by which man may be exposed to the product (events) during each stage. These descriptions identify homogeneous groups of exposed persons and, thus, facilitate the selection of individuals who represent the exposed groups. The radiation doses associated with one year of product use to the total body and to selected reference organs and tissues of representative individuals can be estimated for each mode of exposure that is applicable to each event. Summation of the doses to representative individuals yields group and total population doses. An example of the use of CONDOS is given; the radiation doses associated with a hypothetical product are estimated for assumed conditions of exposure. (auth)

3808 IN VIVO NUCLEAR FISSION IN THE AETIOLOGY OF DECOMPRESSION SICKNESS. Walder, D. N.; Evans, A. (Royal Victoria Infirmary, Newcastle Upon Tyne, Eng.). Nature (London); 252: No. 5485, 696-697(20 Dec 1974).

It is thought that gas bubbles accompany and may well cause decompression sickness, and as gas bubbles do not form in the absence of gas micronuclei (this also applies to supersaturated fluids) it is assumed that the normal human body must contain microbubbles, which may expand during decompression to give the observed effects. It also seems that such microbubbles must be continuously created. It is here suggested that some micronuclei are created in man by spontaneous nuclear fission. If the linear energy transfer to a metastable liquid is sufficiently high the resulting "thermal spike" may nucleate bubbles that can grow to visible size, as in the bubble chamber. In this connection a study was made of the stability of solutions of two α-active isotopes in cold gas-supersaturated water. It was found that tubes containing U were much less stable against gas formation than controls. It was also found that the presence of a heavy metal, such as Pb, did not influence stability. In order to distinguish between the effects of ^{235}U α-emission and the much less frequent spontaneous fission, experiments were made with tubes containing Th. The Th tubes were only marginally less stable than the controls, but there was a highly significant difference between the Th and U results. It is not widely appreciated that spontaneous fission occurs in man, but it appears to occur sufficiently often to maintain a stock of stable gas micronuclei in an average man, and exceptionally may promote bubble formation during one decompression. The body of an average man in the UK contains ~110 μg ^{238}U, and if the SF half-life of ^{238}U is 10^{16} yr man should experience such a disintegration about once every three weeks. The body burden of U resides mostly in bone, and the most common sympton of acute decompression sickness (the bends) is described as a diffuse pain associated with bones. (UK)

3809 TOXICITY OF PLUTONIUM. Spiers, F. W. (Cookridge Hospital, Leeds, Eng.). Lancet; 1: No. 7908, 700-701 (22 Mar 1975).

The dosimetry of plutonium-239 and radium-226 in bone is reviewed, giving the most recent data on which risk estimates can be made. The mean dose-rates to trabecular endosteum and to bone marrow, corresponding to the limits recommended by the I. R. C. P. for occupational exposure to the two radionuclides, are compared on the basis of their differing distributions in bone tissues. Published statistical data on the effects of the long-term exposure of 781 persons to internal α irradiation from radium are then tentatively extrapolated by proportional calculation to give hypothetical estimates of the risks of bone sarcoma and leukemia from a ^{239}Pu body burden maintained at the I. R. C. P. limit of 0.04 μCi. It is emphasized that the dose-response relationship in the radium cases so far reported was very non-linear, and that more sophisticated analysis would lower this estimate of bone sarcoma risk by nearly one order of magnitude. (UK)

Animals

Refer also to abstract 3713.

3810 (ORO-4057-4) RADIATION EFFECT OF RADIOIODIDE THERAPY ON THE HYPOPHYSEAL AND HYPOTHALAMIC FEEDBACK CONTROL CENTERS FOR THYROID FUNCTION STUDIED BY DRY-MOUNT AUTORADIOGRAPHY. Final Technical Report. Stumpf, W. E. (North Carolina Univ., Chapel Hill (USA). Dept. of Physics and Astronomy). 1972. Contract AT(40-4)-4057. 30p. Dep. NTIS $4.50.

Results are reported from studies in rats on the effects of beta radiation from therapeutic doses of ^{131}I on the physiology of the pituitary gland and on brain structures considered thyroid hormone control areas. Iodine-125-labeled triiodothyronine and thyroxine and autoradiographic techniques were used to determine the cellular and subcellular localization of thyroid hormones in

the brain tissues of untreated and thyroidectomized animals. The results suggest that thyroid hormones act on all neurons throughout the mature brain. (CH)

3811 THE SIGNIFICANCE OF LYSINE FOR THE ORGANISM OF EXPERIMENTAL ANIMALS, TREATED WITH SMALL URANYL NITRATE DOSES. Markova, M.; Tsvetanova, J.; Dinoeva, S. Khig. Zdraveopazvane; 16: No. 3, 265-272(1973). (In Bulgarian).

Experimentation is conducted on guinea pigs and rabbits for determining the influence of the amino acid lysine at doses of 2 g per kg body weight and 1 g per kg body weight exerted on the course run by uranium lesions (produced by 0.05 mg/kg body weight uranyl nitrate). Changes are established in the carbohydrate metabolism with hyperglycemia in the initial period and hypoglycemia in later stages; increased pyruvic acid in the blood and changes in the cholesterol metabolism parallel to alternations established in the true blood glucosis; rise of glycogen content in the liver as compared to control animals localized around vv. centrales. It is estimated that amino acid lysine in vivo exerts no prophylactic effect whatsoever in chronic uranium intoxication. (auth)

Nuclide Kinetics and Toxicology

Man

Refer also to abstracts 3726 and 3735.

3812 (AD/A-003413) SOURCE BOOK ON PLUTONIUM AND ITS DECONTAMINATION. Cobb, F. C.; Van Hemert, R. L. (Field Command (DNA), Kirtland AFB, N. Mex (USA)). 24 Sep 1973. 91p. (DNA-3272T). NTIS $4.75.

The contents of this report include: the plutonium hazard; review of U. S. policy and direction concerning plutonium contamination; physical parameters of plutonium contamination; the biology of plutonium contamination; the deposition and retention of inhaled plutonium in the human body; foreign plutonium decontamination standards; and reduction of plutonium contamination hazard. (GRA)

3813 (COO-3382-14(Vol.2), pp II.1-II.24) IN VIVO MEASUREMENTS AND BIOASSAY OF ^{210}Pb IN THE BLOOD AND URINE OF FORMER URANIUM MINERS. Spitz, H. B.; Cohen, N. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

The results of an ongoing program to measure ^{210}Pb in the bone, blood, and excreta of a former uranium miner show a decrease in the ^{210}Pb body burden. In vivo detection of ^{210}Pb in one miner indicates that, between 1972 and 1975, his body burden has decreased from 9.24 +- 0.75 to 8.40 +- 0.03 nCi. The effective half-life of ^{210}Pb in the skeleton was calculated from this change in body burden to be 14.7 +- 0.6 years. From the measured body burden of ^{210}Pb in the skeleton, an estimate of the radon and radon daughter exposure in cumulative working level months (CWLM) was calculated. The calculated cumulative exposure value of 7190 CWLM agrees with the estimated value of 6315 CWLM supplied by HEW. Bioassay for ^{210}Pb in blood and urine was correlated with the in vivo measurements to provide relationships between ^{210}Pb in bone and blood and ^{210}Pb in bone and urine. (auth)

3814 (COO-3382-14(Vol.2), pp V.1-V.26) ENHANCED REMOVAL OF ^{241}Am BY DTPA CHELATION THERAPY IN AN ADULT AND TEENAGE SUBJECT. Sasso, T. L.; Cohen, N. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

A series of Na_3 (Ca-DTPA) chelation treatments were carried out on two human subjects, an adult man and a teenage boy, who have long-term body burdens of ^{241}Am. The in vivo whole-body counting, bioassay of urine and feces, and various blood chemistry measurements were coordinated to coincide with this therapy schedule. Decreases in total body burdens for this treatment period were measured as 5 percent in the adult and 30 percent in the youth. High concentrations of zinc in urine and a corresponding decrease of activity of the zinc-dependent erythropoietic enzyme, ALAD, were also observed. (auth)

3815 COO-3382-14(Vol.2), pp VI.1-VI.12) IS THE LIVER A CRITICAL ORGAN IN MAN FOR ISOTOPES OF AMERICIUM. Cohen, N.; Wrenn, M. E. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

Generation of electrical power by nuclear means will result in the production of substantial quantities of the transplutonium elements. A significant fraction of long-lived alpha-emitting nuclides will be in form of the ^{241}Am and ^{243}Am. Largely regarded as a waste product, americium may eventually find some function, resulting, undoubtedly, in an increase in the number of contamination incidents involving man. To date, there are about 15 documented cases of internal deposition of americium (without plutonium) in man. Experimental results describing the early deposition and rate of removal of ^{241}Am from the liver of the mouse, rat, Chinese hamster, beagle, cynomolgus monkey, baboon, and man are reviewed. (auth)

3816 RADIOLOGICAL HAZARD FROM TRITIUM SORBED ON METAL SURFACES. Eakins, J. D.; Hutchinson, W. P.; Lally, A. E. (UKAEA, Harwell, Eng.). Health Phys.; 28: No. 3, 213-224(Mar 1975).

Experiments with volunteer subjects designed to determine the hazard due to handling metal surfaces contaminated with tritium both as tritium gas and tritiated water are described. Evidence is given for the presence of organically bound tritium in urine after exposure of the skin to tritium gas contaminated surfaces and the significance and chemical form of this organic tritium is discussed. Experiments in which tritium was ingested following hand contamination are described and a comparison is made between the hazard of this route of intake with that of percutaneous absorption. (auth)

3817 ABSORPTION OF NATURAL URANIUM IN THE GASTROINTESTINAL TRACT OF MAN. Svyatkina, N. S.; Novikov, Yu. V. (Uzbek Scientific-Research Inst., USSR). Gig. Sanit.; No. 1, 43-45(Jan 1975). (In Russian).

The results of field observations of the entry and removal of uranium from the body of persons in various age groups of the population of certain districts of the Uzbek SSR showed that 0.9 to 4.3% of uranium, entering the body, is excreted in urine. Consequently, the amount of natural uranium absorbed by the gastrointestinal tract may be considered to comprise 1 to 4%. (auth)

3818 ASSESSMENT OF THE INHALATION ROUTE OF ENTRY AND DEPOSIT OF ENRICHED URANIUM IN CRITICAL ORGANS. Adreeva, O. S.; Shabunin, K. M.; Starodonova, N. P. Gig. Sanit.; No. 1, 39-42(Jan 1975). (In Russian).

Results of field and experimental investigations showed the average amount of enriched uranium aerosols retained in the course of an hour work, to equal 16 ± 4.9% of the total quantity present in the inhaled air. Use of the method of smears made it possible to evaluate the amount of the yearly inhalation entry. The authors compared the extent of uranium deposit in the critical organs with the level of its excretion in urine. (auth)

3819 DIFFUSION OF TRITIATED WATER ACROSS ISOLATED TERM HUMAN AMNION. Page, K. R.; Abramovich, D. R.; Smith, M. R. (Univ. of Aberdeen, Eng.). J. Membrane Biol.; 18: No. 1, 39-48(1974).

The diffusional permeability of isolated human amnion to tritiated water is studied in relation to its histological structure. It is shown that the high permeability of this tissue requires an evaluation of the effects on diffusion of unstirred layers of solution adjacent to the membrane. After correction for such effects the magnitude of the permeability coefficient is found to be both larger and more variable than previously reported. The principal reason for this is found to lie with variations in tissue thickness. The results show that the purposes of water diffusion the amnion may be treated as a homogeneous membrane in the axial coordinate of flow. This finding is discussed in relation to other evidence concerning membrane structure. (auth)

Animals

Refer also to abstracts 3112, 3501, 3763, 3764, 3810, 3815, and 3855.

3820 (COO-3382-14(Vol.1)) RADIOACTIVITY STUDIES. Annual Report, July 1, 1974–June 30, 1975. Eisenbud, M.; Cohen, N. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine). 1 Apr 1975. Contract AT(11-1)-3382. 281p. Dep. NTIS $17.25.

An abstract was prepared for the one paper included in this volume. (CH)

For an abstract of an individual section see: 3821.

3821 (COO-3382-14(Vol.1), pp vp) INVESTIGATION OF THE RETENTION AND DISTRIBUTION OF AMERICIUM-241 IN THE BABOON AND THE ENHANCED REMOVAL OF AMERICIUM-241 FROM THE BODY BY DIETHYLENETRIAMINEPENTAACETIC

ACID (DTPA). Guilmette, R. A.; Cohen, N.; Wrenn, M. E. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

Experiments were performed to study the metabolism and distribution of intravenously administered ^{241}Am in the adult and juvenile baboon; in addition, decorporation therapy using Na_3-CaDTPA was performed on selected baboons to assess the efficacy of this drug in removing systemic burdens of ^{241}Am from this primate species. Determination of the kinetics of ^{241}Am was accomplished principally by in vivo methodologies and by radiochemical analysis of ^{241}Am activity of biological material. The use of Na_3-CaDTPA as a therapeutic agent for the removal of ^{241}Am from the body proved to be an effective form of treatment in the case of early administration. (auth)

3822 (COO-3382-14(Vol.2)) RADIOACTIVITY STUDIES. Annual Report, July 1, 1974–June 30, 1975. Eisenbud, M.; Cohen, N. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine). 1 Apr 1975. Contract AT(11-1)-3382. 180p. Dep. NTIS $12.00.

Separate abstracts were prepared for seven sections of this report. (CH)

For abstracts of individual sections see: 3527, 3806, 3813–3815, and 3822–3824.

3823 (COO-3382-14(Vol.2), pp I.1-I.20) ESTIMATION OF THE SKELETAL CONTENT OF "BONE-SEEKING" RADIONUCLIDES FROM IN VIVO SCINTILLATION MEASUREMENTS OF THEIR ACTIVITY IN THE SKULL. Cohen, N.; Spitz, H. B. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

In-vivo scintillation measurement of the head was determined to be an extremely useful and practical method for estimating the total skeletal burden of various bone-seeking radionuclides such as ^{210}Pb, ^{241}Am, ^{238}Pu, ^{239}Pu, and ^{90}Sr. Specific techniques for making this measurement are described with particular reference to those physical, biological, and geometrical parameters significant for accuracy and precision considerations. (auth)

3824 (COO-3382-14(Vol.2), pp VII.1-VII.4) DESIGN OF LABORATORY AND ANIMAL HOUSING UNIT FOR RADIONUCLIDE STUDIES. 1 Apr 1975.

In radioactivity studies. Annual report, July 1, 1974–June 30, 1975. (New York Univ., N. Y. (USA). Inst. of Environmental Medicine).

The design of a combined analytical laboratory and animal housing facility is discussed. By having sample processing facilities in close proximity to the experimental animals, the necessity for transporting biological specimens long distances has been curtailed. In addition, complete radionuclide counting equipment has been installed so that samples need not leave the animal housing site for analysis, a feature based on radiological health requirements. (auth)

3825 (EUR-5033e(App.)) RADIOTOXICITY OF TRITIUM IN MAMMALS. Critical Analysis of the Extrapolation to Man of the Results of Tritium Incorporation into Animal Tissues. Silini, G.; Metalli, P.; Vulpis, G. (Commission of the European Communities, Luxembourg). 1973. 14p. Dep. NTIS (US Sales Only) $4.00.

A list is presented of some 150 references to literature reporting results of studies on the toxicity of tritium incorporated into mammalian tissues. The possibility of extrapolation of the data to man is also covered. (CH)

3826 (UCRL-76570(Rev. 1)) ROLE OF WATER AND PARTICULATES IN RADIONUCLIDE ACCUMULATION IN THE OYSTER CRASSOSTREA GIGAS. Harrison, F. L.; Wong, K. M.; Heft, R. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Mar 1975. 33p. (CONF-750503-4). Dep. NTIS $4.75.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Changes in ^{54}Mn, ^{60}Co, ^{65}Zn, and ^{137}Cs were followed in oysters introduced into a discharge canal receiving low-level radioactive waste from a boiling water reactor. Groups of animals were maintained either in filtered or nonfiltered discharge-canal water. They were sampled immediately before and after single radioactive releases and at one-day intervals thereafter. Radionuclide concentrations were determined also in the water and in suspended and settled particulates. In the canal water, concentrations changed rapidly during a release, reaching peak values within 30 minutes. The partition between soluble and particulate (filterable) phases in the water differed with the radionuclide. Continuous sampling of suspended particulates after single releases showed considerable variation in concentrations per liter of water for each radionuclide. Comparisons of animals held in filtered water to those in nonfiltered water showed similar concentrations only for ^{137}Cs. Results indicate that suspended particulates play an important role in the accumulation of some radionuclides and that resuspension of particulates is an important source between periods of releases. (auth)

3827 CONTROL OF ^{36}Cl UPTAKE BY ISOLATED SALIVARY GLANDS OF THE LONE STAR TICK. Sauer, J. H.; Frick, J. H.; Hair, J. A. (Oklahoma State Univ., Stillwater). J. Insect Physiol.; 20: No. 9, 1771-1778(Sep 1974).

Salivary glands obtained from non-feeding, adult females of the lone star tick, Amblyomma americanum, did not take up significant amounts of ^{36}Cl after 30 min incubation in vitro. Adenosine-3',5'-monophosphate (cyclic-AMP) and theophylline slightly enhanced uptake in glands obtained from non-feeding ticks. Cyclic-AMP, theophylline, adrenaline, noradrenaline, and dopamine were potent stimulants of ^{36}Cl uptake; but pilocarpine and glutamate were not stimulants of uptake in glands obtained from adult females undergoing the rapid last phase of engorgment. Small amounts of haemolymph obtained from engorging females failed to stimulate uptake as compared to control experimental glands that were incubated in the absence of haemolymph. (auth)

3828 DISTRIBUTION AND EXCRETION OF THREE CHEMICAL SPECIES OF $^{239}Pu(IV)$ IN THE BEAGLE. Stevens, W.; Stover, B. J.; Atherton, D. R.; Bruenger, F. W. (Utah Univ., Salt Lake City). Health Phys.; 28: No. 4, 387-394(Apr 1975).

The early retention and distribution of ^{239}Pu in the beagle were compared following intravenous administration of $^{239}Pu(IV)$ as the transferrin complex (Pu-Tf), as a plutonium complex in citrate buffer (Pu-Cit) of pH 3.5, and as a particulate Pu(IV) in colloidal form (Pu-P). The early distribution and retention of Pu(IV) at 14 days after injection of Pu-citrate and Pu-transferrin were indistinguishable. There was a difference in urinary excretion patterns. Deposition, microdistribution, and retention after administration of a suspension of particulate Pu(IV) differed greatly from those seen in dogs injected with true solutions of plutonium. After injection of Pu-Tf or Pu-Cit, the nuclide was cleared from circulation at a slow rate. Approximately 30% was deposited in the liver, ~50% in the skeleton, and ~2% in other soft tissues. Pu-P left the circulation at a very fast rate, ~70% was deposited in the liver, with only 2% in the bone, and ~24% in other soft tissue. Only an insignificant fraction of the injected Pu-P was excreted. In the liver, the microdistribution after injection of Pu-Tf and Pu-Cit was uniform and Pu(IV) was associated first with soluble protein and later transferred to subcellular liver particles. After injection of Pu-P the microdistribution was heterogeneous; most of the Pu(IV) was located in reticuloendothelial cells and little was associated with soluble proteins. After injection of Pu-Cit and Pu-Tf, Pu(IV) was found on bone surfaces, whereas after injection of Pu-P, the small amount of Pu(IV) present was located exclusively in macrophages of the bone marrow. (auth)

3829 TRANSLOCATION KINETICS OF PLUTONIUM OXIDE FROM THE POPLITEAL LYMPH NODES OF BEAGLES. Dagle, G. E.; Lebel, J. L.; Phemister, R. D.; Watters, R. L.; Gomez, L. S. (Colorado State Univ., Fort Collins). Health Phys.; 28: No. 4, 395-398(Apr 1975).

The translocation kinetics of high-fired plutonium oxide from the popliteal lymph nodes was studied in beagles with 9.2 to 39.4 μCi of ^{239}Pu oxide implanted subcutaneously in the left hind paws to simulate accidental contamination of hand wounds. The left hind paw was amputated 4 weeks after implantation to prevent continued deposition of plutonium oxide particles in the left popliteal lymph node. External in situ scintillation data showed slight clearance of plutonium from the popliteal lymph nodes of beagles monitored for 32 weeks. The estimated time for the fraction of plutonium retained at 100 days to be reduced by one-half varied from 290 to 1508 days. Treatment with DTPA did not have a measurable effect on the clearance of high-fired plutonium oxide from popliteal lymph nodes. (auth)

3830 EFFECT OF FLOW RATE OF LAVAGE FLUID ON THE REMOVAL OF RADIOACTIVE PARTICLES FROM THE LUNG BY BRONCHOPULMONARY LAVAGE. Felicetti, S. A.; Silbaugh, S. A.; Miggenburg, B. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM). Health Phys.; 28: No. 4, 399-403(Apr 1975).

The effect of fluid flow rate during bronchopulmonary lavage to remove radioactive particles from the lungs of beagle dogs

was investigated. Six adult beagle dogs were exposed by inhalation to aerosols of ^{144}Ce in fused clay particles. Four of the dogs were treated with bronchopulmonary lavage of both right and left lungs on day 2 post-exposure. The remaining two dogs were not lavaged and were used to determine the distribution of the inhaled aerosol between the right and left lung. The lavage fluid was introduced into the lung at two flow rates; 0.67 l/min and 1.7 l/min. Lavage of the right lung at the fast rate in two dogs removed 24 and 27% of the right initial lung burden (ILB); lavages of the right lung at the slow rate in the other two dogs removed 35 and 36% of the right ILB. Bronchopulmonary lavage of the left lung of all four dogs, two at the fast rate and two at the slow rate, removed 26, 49, 23, and 30% of the left ILB, respectively. Total amount removed from both lungs was 24 to 40% of the ILB of ^{144}Ce. The order in which the lungs were lavaged did not influence the amount of radiocerium removed. The bilateral procedure did not alter the distribution of material between right and left lung. (auth)

3831 LOSS OF ^{137}Cs AND ^{60}Co FROM THE OYSTER CRASSOSTREA GIGAS. Cranmore, G.; Harrison, F. L. (Humboldt State Univ., Trinidad, CA). Health Phys.; 28: No. 4, 319-333(Apr 1975).

Loss of radionuclides was followed for 10 months in oysters that had been exposed for 7 weeks to ^{137}Cs and ^{60}Co in aquarium systems in which the levels of radioactive and stable cesium and cobalt were held constant. Ten live oysters were whole-body counted individually on a NaI detector at biweekly intervals. The loss of ^{137}Cs was triphasic; its half-times were 1 day in the very short-lived compartment, 8 days in the short-lived compartment, and 70 days in the long-lived compartment. The loss of ^{60}Co was biphasic; its half-times were 40 days in the short-lived compartment and 220 days in the long-lived compartment. Groups of five animals were dissected at 4-day to monthly intervals and loss was followed in total soft tissues as well as in individual body parts. Loss of ^{137}Cs from the soft tissues was triphasic; its half-times in the three compartments were 1, 10, and 90 days. In the total soft tissues, ^{60}Co loss was biphasic; its half-times in the two compartments were 7 and 130 days. Among the body parts, half-times as well as the Day 0 radionuclide concentration varied considerably. For most body parts three compartments of ^{137}Cs and two compartments of ^{60}Co were resolved. Turnover rates were slower and concentration factors were higher for cobalt than for cesium. (auth)

3832 DEPOSITION OF CALCIUM PHOSPHATE INTO DENTIN AND ENAMEL AS SHOWN BY RADIOAUTOGRAPHY OF SECTIONS OF INCISOR TEETH FOLLOWING INJECTION OF ^{45}Ca INTO RATS. Munhoz, C. O. G.; Leblond, C. P. (McGill Univ., Montreal). Calcified Tissue Res.; 15: No. 3, 221-235(1974).

To find out whether the calcium phosphate of dentin and enamel is elaborated in the cells prior to passing into the organic matrix or is initially deposited into the matrix, rats were injected intravenously with ^{45}Ca and killed 30 sec or 5 min later by glutaraldehyde perfusion; semithin sections of the undecalcified incisor teeth were then radioautographed for detection of the incorporated ^{45}Ca. Rat incisor teeth were selected since there is evidence that the calcium they take up is stable; that is, not subject to significant loss by exchange or by other physiochemical processes. When dentin is examined after ^{45}Ca injection, the maximum radioautographic reaction is observed next to the junction with predentin and a gradual decrease up to the dentin enamel border. No radioactivity is detected in odontoblasts. These observations are interpreted as indicating that the initial site of calcium phosphate deposition is in the matrix of dentin. In the enamel, the radioautographic reaction is spread fairly uniformly throughout the matrix, with a weak reaction over ameloblasts attributed to radiation scatter. The interpretation is again that calcium phosphate is deposited into the matrix; and, furthermore, that this deposition begins as soon as the matrix is laid down and continues at about the same rate up to an advanced stage of mineralization. (auth)

3833 COMPARATIVE ANALYSIS OF THE BEHAVIOR OF TWO PREPARATIONS OF LABELED ACTH IN THE ORGANISM. Tkacheva, G. A.; Petrova, G. A. (Scientific-Research Inst. of Medical Radiology, Obninsk, USSR). Probl. Endokrinol.; 21: No. 2, 62-65(1975). (In Russian).

Experiments were conducted on male Wistar rats. A study was made of the intensity of incorporation into the liver, kidneys, the thyroid gland, the adrenal glands and the rate of elimination from the blood plasma of two ACTH preparations iodated by Greenwood's method: International Standard for Corticotropin, Mill Hill, London; Hum ACTH–Hid-28, Richter. It appeared that the preparations of natural swine ^{125}I-ACTH and of synthetic ^{131}I-ACTH were identical chromatographically and by saturation with iodine-125 and iodine-131, respectively, but differed by their behaviour in the organism. $T\frac{1}{2}$ for ^{125}I-ACTH (swine) was 4.7 min; the hormone was not incorporated into hepatic parenchyma, and only very weakly–into the kidneys, but it was intensively accumulated by the adrenal glands. Radioactivity peak was recorded in the adrenal cortex 6 minutes after the administration of the labeled hormone. ^{131}I-ACTH (synthetic) disappeared from the blood with a half-period of 11.2 min, was incorporated into the liver and particularly into the kidneys, and was not accumulated in the adrenal gland. (auth)

3834 TISSUE DISTRIBUTION OF TRITIATED GASTRIN AND PENTAGASTRIN IN THE RAT. Lanciault, G.; Gislon, J.; Accary, J. P.; Bonfils, S. (Unite de Recherches de Gastroenterologies, Paris). Proc. Soc. Exp. Biol. Med.; 148: No. 4, 1081-1086(Apr 1975).

Tritiated synthetic gastrin I: 1-17 and a C-terminal peptide analogue (BOC-Gly-Trp-Met-Asp-PheNH$_2$) with a specific radioactivity of 45 and 7 Ci/mmole respectively, were found to disappear very rapidly from the blood when given iv to anesthetized rats. The calculated half-life for gastrin and the peptide analogue was 1,8 and 3,0 min respectively. The tissues which showed the greatest affinity for radioactivity with gastrin was the kidney, gastric fundus, liver and pancreas in the order of concentration. With pentagastrin, the pancreas, liver and proximal duodenum concentrated radioactivity to the highest degree. The results also indicate that, once injected into the rat, the labelled products which remain in the blood undergo modification. Although the results presented do not give any indication how these modifications take place, it is possible that the organs which sequester the products modify them and then re-released them into the blood stream. Whether or not these modified forms are active biologically is open to conjecture. (auth)

Plants

Refer also to abstract 3499.

3835 ^{137}Cs IN THE REINDEER LICHEN CLADONIA ALPESTRIS: DEPOSITION, RETENTION, AND INTERNAL DISTRIBUTION, 1961-1970. Mattsson, L. J. S. (Univ. of Lund, Sweden). Health Phys.; 28: No. 3, 233-248(Mar 1975).

Accumulation of the fallout radionuclide ^{137}Cs was studied in a large number of samples of the important reindeer lichen Cladonia alpestris, collected in the Lake Rogen area (62.3°N, 12.4°E) in central Sweden during the period 1961 to 1970. The maximum area-content of ^{137}Cs in the lichen carpet occurred in 1965 and 1966 and amounted to 46 to 66 nCi/m^2, which corresponds to a dry mass content of 34 to 52 nCi/kg, due to the special characteristics of the lichen carpet and of the locality itself. In September 1970 the ^{137}Cs levels for the whole lichen carpet were 50 to 80% of the values obtained in 1965. The vertical distribution of ^{137}Cs was studied during 1966 to 1970 and the results indicate the existence of a short-time internal cycling of the radionuclide in the lichen carpet, so that in dry periods certain amounts of ^{137}Cs are forced up to the top regions of the carpet and in periods of high precipitation washed down to its lower layers. The concentration of ^{137}Cs at various depths recorded in carefully field-fractionated samples of lichen, gelatinous matter, humus, and soil collected in the normal years 1969 and 1970 follows the empirically found relation: $c = \text{constant} \exp(-1{,}6\, z^{0.75})$, where c denotes the ^{137}Cs concentration in dry matter (nCi/kg) at the dry mass depth z (kg/m^2). For comparison with the ^{137}Cs results, the vertical distribution of two other alkali metals, potassium and sodium have also been studied. According to increasing penetration of the lichen carpet, the elements can be arranged in the following sequence: $^{137}Cs \approx K \ll Na$. The principal ways for elimination of ^{137}Cs from undisturbed carpets of Cladonia alpestris are physical decay of the radionuclide and the continuous growth of the lichen plants, the latter combined with a continuous decomposition of older material. (auth)

Microorganisms

Refer also to abstract 5800.

New Tracer Techniques

Refer also to abstracts 3063, 3713, and 3810.

3836 (AD/A-001935) PERCENT BODY WATER MEASUREMENT USING IN VIVO D_2O DILUTION AND DEUTERON PHOTODISINTEGRATION. Preliminary Report, 1 September 1973–31 July 1974. Hyder, A. K.; Stansell, M. J.; Caldwell, J. T. (Frank J. Seiler Research Lab., U.S.A.F. Academy, Colo. (USA)). Aug 1974. 13p. (SRL-TR-74-0019; USAFA-TR-74-16). NTIS $3.25.

The measurements of percent body water, lean body mass, and body fat are generally associated with technical difficulties, safety limitations, and inherent accuracies. Using D_2O dilution for this purpose is comparatively safe but has, in the past required quantification by relatively insensitive and laborious methods. A promising new approach to quantifying D_2O in serum samples is based on the photodisintegration of the deuteron, in which a high energy gamma ray initiates the breakup of a deuterium nucleus into a proton and a neutron. The proton is stopped in the serum sample and is not detected. The emitted neutron, with higher probability of escape, is detected by standard procedures. The technique is amenable to automation, low D_2O doses, and permits determination of percent body water, lean body mass, and body fat at even lowest echelon medical facilities. (GRA)

3837 (AD/A-002582) PRESENT CONCEPTS IN INTERNAL MEDICINE. Volume VII, Number 3, May–June 1974. Heath, H. III; Applewhite, L. B. (Letterman Army Medical Center, San Francisco, Calif. (USA)). Jun 1974. 87p. NTIS $4.75.

Eight articles present aspects of the expanding knowledges of endocrine physiology and advancing technology which will benefit diagnosing and therapy of patients. Competitive protein binding assay, i.e., "radioimmunoassay" allows the quantification of minute amounts of hormones. The lead article illustrates the contribution of nuclear medicine to endocrinology. Recent developments in diabetes, problem of the thyroid nodule, discussion of triiodothyronine as the real thyroid hormone, pharmacologic uses of glucocorticoids, pathogenesis and prophylaxis of calcium containing renal stones, calcium homeostasis and parathyroid hormone radioimmunoassay are the subjects of the articles and illustrate the scope of the symposium. (GRA)

3838 (BNWL-SA-5353) DETERMINATION OF VARYING CONSUMPTION RATES FROM RADIOTRACER DATA. Cadwell, L. L.; Schreckhise, R. G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1975. Contract AT(45-1)-1830. 12p. (CONF-750503-12). Dep. NTIS $4.00.

From 4th national symposium on radioecology; Corvallis, Oregon, USA (12 May 1975).

Data obtained on the uptake and elimination of ^{32}P by foraging grasshoppers were utilized to estimate consumption rates of blue grama grass (Bouteloua gracilis). (auth)

3839 (UCLA-34P119-32) CLINICAL APPLICATIONS OF A HIGH QUANTUM UTILIZATION SCANNER. Final Report. Crandall, P. H.; Cassen, B. (California Univ., Los Angeles (USA)). Apr 1973. Contract AT(04-3)-34. 32p. Dep. NTIS $4.75.

The clinical usefulness of a tomographic imaging process employing a fast rectilinear scanner consisted of a spherical-cap nest of seven individual detectors (3" x ½" activated sodium iodide) collimated to a common focal point at 10 cm. Hydraulic drives permitted a fast rectilinear scan to be made and, when raised or lowered, at different planes. Patients with well-defined brain lesions were studied using ^{99}/super m/Tc-pertechnetate or ^{203}Hg-chlormerodrin as tracers by measuring three dimensions of their lesions and anatomical location at the time of operation. Brain maps were used to identify this location at operation and also the location of images traced from film density displays of a conventional radioisotopic scan, the tomographic scan, and cerebral angiograms. (auth)

3840 BIOLOGICAL METHOD FOR ASSESSMENT OF DIAGNOSTIC USEFULNESS OF COLLOIDAL SOLUTIONS, MACROAGGREGATES, AND ^{113m}In COMPLEXES. Licinska, I.; Krasucki, T.; Rybakow, Z.; Krajewska, A. Pol. Przegl. Radiol. Med. Nukl.; 38: No. 6, 755-760(1974). (In Polish).

In widely used methods of scintigraphic diagnosis a considerable role is played by short-lived ^{113m}In owing to its convenient physicochemical features. The differences in biological distribution of various ^{113m}In compounds are used in the diagnosis of many diseases. On the basis of a sterile ^{113}Sn–^{113m}In generator a method of obtaining three compounds of indium: colloid, macroaggregate, and ^{113m}In-DTPA complex was elaborated at the Centre of Isotope Production and Distribution in Swierk. The biological assessment of these radiopharmaceutic agents by the Department of Isotope Drugs, Institute of Drugs showed that the preparations equal in quality those offered by the Radiochemical Centre Amersham. (auth)

3841 ACUTE VIRAL HEPATITIS IN ADULTS. Comparison of the Radioimmunoassay and Counterimmunoelectrophoresis Methods of Detecting HB/sub s/Ag. Wenzel, R. P. (Univ. of Virginia, Charlottesville); Teates, C. D.; Galapon, Q.; Barczak, R.; Ling, C. M.; Overby, L. R. J. Amer. Med. Ass.; 232: No. 4, 366-368(28 Apr 1975).

The radioimmunoassay (RIA) and counterimmunoelectrophoretic (CIE) methods were compared in detecting hepatitis B antigen (HB/sub s/Ag) in 407 acute and 336 convalescent sera of adults with viral hepatitis. The CIE method demonstrated that 41 percent of acute and 28 percent of 14- to 17-day serum specimens were HB/sub s/Ag-positive. The RIA method demonstrated seropositivity in 60 percent of acute and 56 percent of convalescent specimens (P less than .001). Eighty-four percent of coded specimens initially positive for HB/sub s/Ag by RIA were found to have subtype antigenic determinants d or y; 92 percent of the HB/sub s/Ag-negative controls were negative for subtype antigens, confirming the specificity of the RIA test. RIA subtyping data corroborated earlier work with immunodiffusion techniques. (auth)

3842 PSOAS ABSCESS LOCALIZATION BY GALLIUM SCAN IN APLASTIC ANEMIA. Oster, M. W.; Gelrud, L. G.; Lotz, M. J.; Herzig, G. P.; Johnston, G. S. (National Cancer Inst., Bethesda, MD). J. Amer. Med. Ass.; 232: No. 4, 377-379(28 Apr 1975).

Gallium 67 scanning is an effective method of detecting inflammatory lesions, especially abscesses. A 10-year-old boy with aplastic anemia and severe leukopenia and granulocytopenia had a psoas abscess diagnosed by gallium scan. The patient died with Candida sepsis 18 days after bone marrow transplantation. At autopsy, a chronic psoas abscess with Candida was found. The gallium scan offers a clinically effective and noninvasive means of evaluating suspected infection in the granulocytopenic patient. (auth)

3843 MULTIPLE ISOTOPIC PROBES OF CATALYTIC STEPS AND SPATIAL SELECTIVITY OF GLUTAMINE SYNTHETASE. Stokes, B. O. Los Angeles; Univ. of California (1974). 80p. University Microfilms Order No. 75-9438.

Thesis (Ph. D.).

Rates of interchange of substrates labeled with ^{18}O, ^{32}P, and ^{14}C were measured during net catalysis by glutamine synthetases. Results give information about the relative rates of individual steps in the catalytic sequence and about possible spatial selectivity between the oxygens of the gamma-carboxyl group of enzyme-bound glutamate. Transfers of ^{18}O from P/sub i/ to glutamine (O/sub P/sub i// yields O/sub gluNH/sub 2/) and from P/sub i/ to glutamate (O/sub P/sub i// yields O/sub glu//) were measured during the initial reaction of glutamine, ADP and P/sub i/. In all cases E. coli glutamine synthetase catalyzes the O/sub P/sub i// yields O/sub gluNH/sub 2// reaction at a much faster rate than that of the O/sub P/sub i// yields O/sub glu/ reaction. These and previous data from other investigators make it probable that the relative orders of some of the catalytic steps are: ATP release less than NH_3 release less than glutamate release less than substrate interconversion, and/or glutamine release, and/or P/sub i/ release. In addition the data suggest the following differences: substrate interconversion less than glutamine release and glutamate release less than ADP release. The large O/sub P/sub i// yields O/sub gluNH/sub 2// flux eliminates the possibility of spatial distinction between oxygens of the gamma-carboxyl of bound glutamate during catalysis by E. coli glutamine synthetase. This oxygen transfer is only possible if the gamma carboxyl is free to rotate faster than the rate of interconversion of bound substrates and cannot occur if the carboxyl oxygens are spatially fixed during overall catalysis. Limited oxygen flux measurements using glutamine synthetases from pea seeds and ovine brain showed little if any O/sub P/sub i// yields O/sub gluNH/sub 2// flux. In contrast to the measurements for the E. coli enzyme, these and earlier results are consistent with spatial selectivity in these two enzymes. Methods have been developed for the requisite separations for ^{18}O analyses including preparation of a convenient lyophilizable buffer system (triethyl ammonium formate). (Diss. Abstr. Int., B)

3844 DETECTION OF SKELETAL INVOLVEMENT IN HODGKIN'S DISEASE: A COMPARISON OF RADIOGRAPHY, BONE SCANNING, AND BONE MARROW BIOPSY IN 38 PATIENTS. Ferrant, A.; Rodhain, J.; Michaux, J. L.; Piret, L.; Maldague, B.; Sokal, G. (Univ. Clinics, Louvain, Belgium). Cancer; 35: No. 5, 1346-1353(May 1975).

As part of the staging of 38 patients with Hodgkin's disease seen over an 18-month period, we have used radioisotopic scanning of bone, as well as radiography and bone marrow biopsy, in an attempt to assess osseous and bone marrow involvement. Of the 38 patients, 14 were found to have skeletal involvement. In 11 this was histologically proved. In 8 patients, the radioisotopic scan first raised the suspicion of localized bone involvement, which was subsequently proved by bone marrow biopsy or by radiography. We believe that bone marrow involvement may at times be localized when patients with Hodgkin's disease are first staged and may precede local osseous involvement. If this is so, a reasonable approach to the search for bone marrow or osseous involvement would be to start with a bone scan and to follow this with a bone marrow biopsy from the suspicious area or a careful radiography of the same site; the latter is

important if the site of increased uptake of the radionuclide is inaccessible to the biopsy needle. (auth)

3845 ISOLATION OF FECES AND BILE IODATE COMPOUNDS BY FILTRATION THROUGH SEPHADEX G 25 M. Study of the Entero-Hepatic Metabolism of ^{125}I-Thyroxine. Ikeda, E.; Nicolau, W.; Muramoto, E.; de Assis, L. M.; Pieroni, R. R. (Inst. of Atomic Energy, Sao Paulo, Brazil). Rev. Assoc. Med. Bras.; 19: No. 4, 1-14(Apr 1973). (In Spanish).

Bile "in natura" and butanolic extract from duodenum, ileum, and rectum contents were submitted to filtration through Sephadex G 25 M gel. This procedure resulted in the separation of four radioactive peaks. The composition of each peak has been analyzed by paper chromatography. Although peak I seems to be partially composed of iodinated proteins, its actual composition has not been determined. Peaks II and III are due, respectively, to iodide and T_3 and/or T_4. The data obtained by means of paper chromatography of peak IV, after treatment with β-glucuronidase, led to the assumption that it might be mainly glucuronic derivates of T_3 and/or T_4. (auth)

3846 VISCERAL RADIOISOTOPIC LYMPHOGRAPHY OF THE TESTICLE. Karparov, M. (Radioisotopic Center with Radiological Clinic, Plovdiv, Bulgaria). Neoplasma; 22: No. 1, 91-98(1975).

Scintigraphic studies made in 75 patients, respectively on 130 testicles with the aid of the organ radioisotopic lymphography enabled to determine more exactly the location and the variety of the testicular lymph centers. It should be pointed out that in 58.5% of the patients the lymph centers are situated on the left of the middle line and only in 6.1% on the right. In some cases iliac lymph nodes were demonstrable. Attempts were made to use this method in investigation of the patients with malignant tumors of the testicles. (auth)

3847 DETERMINATION OF APOCERULOPLASMIN BY RADIOIMMUNOASSAY IN NUTRITIONAL COPPER DEFICIENCY, MENKES' KINKY HAIR SYNDROME, WILSON'S DISEASE, AND UMBILICAL CORD BLOOD. Matsuda, I.; Pearson, T.; Holtzman, N. A. (Johns Hopkins Univ., Baltimore). Pediat. Res.; 8: No. 10, 821-824(Oct 1974).

Radioimmunoassay can detect as little as 10 ng apoceruloplasmin. Interference by holoceruloplasmin is overcome by using an antiapoceruloplasmin antibody absorbed with holoceruloplasmin and by correcting for the relatively small inhibition of binding of apoceruloplasmin to absorbed antibody caused by holoceruloplasmin. The apoceruloplasmin concentration in infants with nutritional copper deficiency (2.9 ± 0.9 mg/100 ml), Menkes' kinky hair syndrome (1.4 ± 0.5 mg/100 ml), and Wilson's disease (2.7 ± 2.0 mg/100 ml) did not differ significantly from normal (3.3 ± 3.1 mg/100 ml) despite significant reductions ($P < 0.01$) in the concentration of holoceruloplasmin in each of these conditions. In umbilical cord blood from normal neonates, however, the concentration of apoceruloplasmin (0.7 ± 0.5 mg/100 ml) was significantly lower than normal ($P < 0.01$), as was the concentration of holoceruloplasmin. (auth)

3848 LOCALIZATION OF ^{125}IODIDE AND IODINATED (^{125}I) ALBUMIN IN AUTORADIOGRAPHIC MODEL EXPERIMENTS. Thesingh, C. W.; Driessen, O. M. J.; Bosch, N. V. D. (Univ. of Leiden). Histochemistry; 39: No. 4, 345-349(1974).

In previous autoradiographic model experiments with diffusible substances, the resolution of ^{125}iodide appeared to be worse than that of tritiated compounds. This could be attributed to a difference in type of radiation (resulting in overradiated autoradiographs made with ^{125}iodide) or to a difference in diffusion. In the present experiments, autoradiographs of trachea segments filled with high and low quantities of free ^{125}iodide and albumin-bound ^{125}Iodine were compared and the resolutions estimated. Overradiation (high quantities of the radioactive substances) did not influence the resolution, but enlarged the distance from the source to background level. Irrespective of the quantity of radioactivity, a significant difference in resolution was found between ^{125}iodide and iodinated (^{125}I) albumin. Moreover, the resolution of iodinated (^{125}I) albumin was the same as that of tritiated compounds. The conclusion was made that the difference in resolution between ^{125}iodide and tritiated compounds was due to a greater diffusion of iodide ions during the experimental procedure. (auth)

3849 LABORATORY EXAMINATION OF THE THYROID. I. In Vitro Tests. Schneider, P. B. (Harvard Medical School, Boston). J. Appl. Med.; 56: No. 2, 91-96(Aug 1974).

There are many methods for evaluating thyroid disease, but one or two relatively simple tests are adequate in most cases. The more specialized tests or combinations of tests are useful in the few patients who have unusual thyroid disorders or equivocal results in the simpler tests. Basic tests include protein-bound iodine, T_4 by displacement, T_3 resin uptake, and free T_4 index. Valuable tests not yet widely available include T_3 and TSH radioimmunoassays. (auth)

3850 LABORATORY EXAMINATION OF THE THYROID. II. In Vivo Tests. Schneider, P. B. (Harvard Medical School, Boston). J. Appl. Med.; 56: No. 2, 101-106(Aug 1974).

In vivo tests of thyroid function are indicated if results of in vitro tests are inconclusive, equivocal, or require confirmation. These tests are based on the thyroid's ability to concentrate iodine and involve administration of a radioisotope and external detection. The radioactive iodine uptake test involves measuring thyroid activity, in some cases before and after thyroid stimulation or suppression. Scanning gives a picture of the gland itself. (auth)

3851 DETERMINATION OF THE RATE OF HEXOKINASE-GLUCOSE DISSOCIATION BY THE ISOTOPE-TRAPPING METHOD. Rose, I. A. (Inst. for Cancer Research, Philadelphia); O'Connell, E. L.; Litwin, S.; Tana, J. B. J. Biol. Chem.; 249: No. 16, 5163-5168(25 Aug 1974).

When (^{14}C)glucose is mixed with yeast hexokinase and subsequently diluted with 0.18 mM MgATP and a large amount of unlabeled glucose, half of the enzyme-bound (^{14}C)glucose is converted to glucose-6-P prior to dissociation. At higher concentrations of ATP, all of the bound (^{14}C)glucose is trapped as glucose-6-P indicating that the binary complex is fully functional and that the ternary complex goes to product much more rapidly than it dissociates glucose. An equation is derived that gives the dissociation rate constant of the enzyme glucose complex, k/sub off/, in terms of steady state kinetic parameters, k/sub cat/ and K/sub m/ of ATP, and the concentration of ATP required for half-maximum trapping, K/sub ½/: k/sub off/ equals K/sub ½/ k/sub cat//K/sub m/. It is concluded that glucose dissociates from the binary complex at 29 percent of the net forward reaction rate and that this step is rate determining for the reverse reaction K/sub max/. The forward reaction cannot be viewed as pre-equilibrium, at least with respect to glucose binding. Isotope trapping as applied here provides a new approach for determining the sequence of binding of substrates to enzymes and for estimating the rates of dissociation of substrate from binary and ternary Michaelis complexes in reactions requiring two or more substrates. Slow dissociation of E S complexes must be ruled out in isotope trapping experiments meant to show covalent intermediates. (auth)

3852 CONGENITAL GOITER DUE TO MATERNAL INGESTION OF IODIDE. Iancu, T.; Boyanower, Y.; Laurian, N. (Sharon Hospital, Petah-Tiqva, Israel). Am. J. Dis. Child.; 128: No. 4, 528-530(Oct 1974).

A newborn infant with large bilateral cervical masses developed respiratory difficulties three days after birth. A congenital goiter was suspected and a biopsy was performed. Later information pointed to the ingestion of large amounts of inorganic iodine, during the pregnancy, by the asthmatic mother. Further investigation proved the goiter to be due to transient depression of peroxidase activity by the exogenous iodine. Within several days after birth, the infant's thyroid regained its full activity, the goiter disappeared, and the few signs of hypothyroidism subsided. (auth)

3853 ADVANTAGES OF ^{131}I-ORTHOIODOHIPPURATE SCINTIPHOTOGRAPHY IN THE MANAGEMENT OF PATIENTS AFTER RENAL TRANSPLANTATION. Salvatierra, O. Jr.; Powell, M. R.; Price, D. C.; Kountz, S. L.; Belzer, F. O. (Univ. of California, San Francisco). Ann. Surg.; 180: No. 3, 336-342(Sep 1974).

Renal scintiphotography with ^{131}I-hippurate was the primary diagnostic procedure in evaluating renal failure and complications in over 500 transplant patients. This diagnostic test has become the principal method of evaluation and followup of renal transplants, especially in the early post-transplant period. It has accurately distinguished tubular necrosis, rejection, and other complications in the post-transplant period. Its simplicity, safety, and accuracy are of great value to transplant surgeons and their patients. (auth)

3854 BLOOD FLOW IN HUMAN MUSCLE DETERMINED FROM THE RATE OF ^{133}Xe CLEARANCE. Vinogradova, O. L.; Kots, Ya. M.; Rodionov, I. M.; Savchenko, A. P.; Tkhorevskii, V. I. (First Medical Inst., Moscow). Fiziol. Zh. SSSR No. 7, 1065-1073(1974). (In Russian).

A comparative study was conducted of changes in blood flow in the human soleus (red muscle) and anterior tibia (white muscle) under various conditions after local injection of radioxenon. The rate of blood flow in the soleus at rest was 39% higher than that in the tibia. After 5 minutes of slight contraction (10% of the maximum), there was no significant difference between the two muscles. After 1 minute of maximum contraction, the resulting hyperemia was substantial in both muscles, but more so in the tibia. Similarly after tension induced by mental arithmetic, the blood flow increased considerably in both muscles; the increase

was higher, in most cases, in the tibia. The differences in hemodynamics between the two muscles is ascribed to differences in types and numbers of fibers. (JPRS)

3855 INVESTIGATION OF ^{68}Ga–TRIPOLYPHOSPHATE AS A POTENTIAL BONE-SCANNING AGENT. Goulet, R. T.; Shysh, A.; Noujaim, A. A.; Lentle, B. C. (Alberta Univ., Edmonton). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 195-199(Apr 1975).

A procedure is described for the preparation of carrier-free ^{68}Ga–tripolyphosphate and ^{66}Ga–gallium tripolyphosphate. These radiopharmaceuticals were evaluated and compared as potential bone-imaging agents. A tissue distribution study demonstrated that the respective concentration of these preparations in bone was 43 and 64% of the administered dose four hours after intravenous injection into mice. The toxicity of these chemicals was determined and bone images of rabbits were obtained using a positron camera. (auth)

3856 AUTOLOGOUS ^{125}I-FIBRINOGEN UPTAKE TEST IN THE DETECTION AND MANAGEMENT OF VENOUS THROMBOSIS: A PROSPECTIVE STUDY. Pollak, E. W.; Weber, M. M.; Barker, W. F.; Victery, W.; Cragin, M.; Witt, E. (Univ. of California, Los Angeles). Arch. Surg. (Chicago).; 109: No. 1, 48-51(Jul 1974).

The ^{125}I-fibrinogen uptake test (FUT) was evaluated in a series of 42 subjects to determine its ability to detect active venous thrombosis. Included were patients with recent active thrombosis, patients with long-standing quiescent venous obstruction, and normal controls. In serial tests, increasing isotope uptake was found to occur only in patients with active thrombophlebitis (P less than .01). Consequently, this criterion can serve as an index of active thrombophlebitis. Five patients with known calf vein thrombosis had increasing FUT results at the upper thigh. Phlebography or technetium scans confirmed propagation of the thrombosis. These results suggest a screening value for the FUT in suspected propagating thrombosis. If results are confirmed by subsequent phlebography, major therapeutic changes such as intensification of anticoagulation or venous interruptions can hopefully be made before potentially lethal pulmonary embolism occurs. (auth)

3857 RADIONUCLIDE AORTOGRAPHY IN DETECTION OF ARTERIAL ANEURYSMS. Bergan, J. J.; Yao, J. S. T.; Henkin, R. E.; Quinn, J. L. III. (Northwestern Univ., Chicago). Arch. Surg. (Chicago); 109: No. 1, 80-83(Jul 1974).

In a study designed to assess the potential value of radionuclide aortography in diagnosis of aortic and anastomotic aneurysms, 43 patients were examined. Radionuclide studies correctly identified 26 of 28 aortic aneurysms while physical examination identified 26 of 28, and lateral plain film roentgenograms showed 23 of 28. Three of five anastomotic aneurysms were demonstrated by the radionuclide techniques. The radionuclide study was helpful in finding three previously unsuspected aneurysms and in excluding four abdominal and three thoracic masses from consideration as aneurysms. Clearly, this noninvasive technique has utility in lending objectivity to evaluation of patients with arterial aneurysm disease. (auth)

3858 NON-CHROMATOGRAPHIC RADIOIMMUNOASSAY FOR SERUM DEHYDROEPIANDROSTERONE USING A MIXTURE OF ANTISERA. Sekihara, H.; Ohsawa, N. (Univ. of Tokyo). Steroids.; 24: No. 3, 317-326(Sep 1974).

A simplified method for evaluating serum dehydroepiandrosterone (DHEA) without chromatography was developed, using mixtures of two different anti-DHEA antisera, anti-3beta-hydroxy-DELTA^5 antiserum and anti-11-deoxy-17-ketosteroid antiserum, in which cross-reactivity of each antiserum is reduced to a negligible amount. Serum (20 mu l) was extracted with 1 ml of n-hexane. One milliliter of 80 percent methanol was added to the n-hexane extract, which was stirred and centrifuged. The n-hexane layer was discarded, and the methanol layer was evaporated to dryness. The residue was incubated with an antiserum mixture containing DHEA-7alpha-^{3}H, pepsin-treated human immune serum globulin and bovine serum albumin. Ammonium sulfate was used to separate free from bound DHEA-7alpha-^{3}H. The accuracy, precision, sensitivity, and specificity were satisfactory. Good agreement was found between the serum DHEA levels obtained by the present radioimmunoassay and those obtained by radioimmunoassay with paper chromatography, making this method suitable for routine use. (auth)

3859 SEPHADEX COLUMN RADIOIMMUNOASSAY OF UNCONJUGATED ESTRIOL IN PREGNANCY PLASMA. Christner, J. E.; Fetter, M. C. (Ames Co., Elkhart, IN). Steroids.; 24: No. 3, 327-342(Sep 197.).

A rapid, precise, and accurate radioimmunoassay for unconjugated estriol in pregnancy plasma has been developed which makes use of the adsorptive properties of Sephadex. The estriol is extracted from plasma by adsorption onto a small column of Sephadex. After the proteins and other interfering materials are washed away, the estriol is equilibrated with a limiting amount of specific antibody. The Sephadex column serves as a means of separating the bound from the unbound estriol, the ratio of which is determined by adding to the system tracer amounts of tritium-labeled hormone. The sensitivity is about 220 pg in the sample. The intra- and inter-assay coefficient of variation is 5 to 6 percent. The method correlated well with one which involved purification of the estriol prior to quantitation by radioimmunoassay. (auth)

3860 SERIAL RADIONUCLIDE QUANTITATIVE FUNCTION STUDIES FOR EVALUATION OF RENAL TRANSPLANTS. Martin, D. C.; Hunter, J. L.; Lawton, M. B.; Berke, R. A.; Morton, M. E. (Univ. of California, Irvine). J. Urol.; 112: 2-7(Jul 1974).

A new method of assessing renal function following transplantation has been presented. The calculated rate of transfer to the kidney expressed as percent per minute, effective renal blood flow in milliliters per minute and the percentage of the dose in the urine at 20 minutes are calculated from data derived from a scintillation probe over the heart following a single injection of radiohippuran. These indices provide a means of interpreting serial determinations of renal function in states in which the more conventional parameters of renal function are not reliable. (auth)

3861 DEPOSITION OF RADIONUCLIDE-LABELED CIGARETTE SMOKE IN DOGS. Wehner, A. P.; Bair, W. J.; Haller, W. A.; Case, A. C. (Pacific Northwest Labs., Richland, WA). J. Appl. Physiol.; 37: No. 4, 630-633(Oct 1974).

Cigarettes labeled with ^{82}Br, ^{24}Na, and ^{42}K by exposure to 8 x 10^{16} neutrons/cm^2 were smoked by dogs in an exposure system facilitating oral inhalation of the cigarette smoke. Deposition of the labeled cigarette smoke in the dogs was measured by whole-body counting and analysis of blood and excreta. Bromine 82 was the best suited tracer. It could be detected by whole-body counting for up to 9 days as compared to 3 and 4 days for ^{42}K and ^{24}Na, respectively. Blood levels of ^{82}Br could be monitored for 4 days. Excreta also showed detectable levels of ^{82}Br for 4 days. Between 30 and 70 percent of the ^{82}Br body burden occurred in the blood where it was retained for an appreciable period of time. The ^{82}Br blood level was a linear function of the number of cigarettes smoked whereas whole-body counts showed a decrease in Br, K, and Na deposited per cigarette as more cigarettes were smoked. The maximum total body radiation dose received by a dog smoking one neutron-activated cigarette was less than 5 x 10^{-4} rads which makes this technique applicable to studies with human subjects. (auth)

3862 INVESTIGATION OF ^{42}K METABOLISM BY THE METHOD OF THE WHOLE-BODY RADIOMETRY IN PATIENTS WITH MYOPATHIES. Palinkashi, D. G.; Sitnikov, V. F.; Sychev, V. K.; Leskova, N. N. (Moscow Medical Inst.). Med. Radiol.; 20: No. 4, 24-27(Apr 1975). (In Russian).

Radiometry of the whole body was used to investigate ^{42}K metabolism in 27 patients (patients with myopathies, their relatives and patients with neural muscular atrophy). This made it possible to make quantitative assessment of potassium metabolism with due account for its content in the tissues. It is shown that determination of potassium content in the blood in patients with muscular diseases has no diagnostic value. This method made it possible to reveal latent potassium deficiency in practically healthy relatives of patients with myopathies and quantitatively assess the efficacy of treating disturbed potassium metabolism. (auth)

3863 DIAGNOSTIC VALUE OF POLYPROJECTION HEPATOSCANNING IN LIVER CIRRHOSIS. Sukirno, M. S.; Suchkov, A. V.; Yudin, L. A. (Moscow Medical Inst.). Med. Radiol.; 20: No. 4, 17-24(Apr 1975). (In Russian).

The method of color polyprojection hepatoscanning with the aid of ^{198}Au was used to examine 25 healthy individuals and 48 patients with liver cirrhosis. When analyzing hepatoscannograms, the following indices were taken into consideration: total area, length and thickness of the liver, right and left diameters, percentage of the sum total area of the active zone of accumulation, and total area of the spleen. All the planimetric data of the hepatoscannograms were treated by the method of variation statistics. While in hepatoscanning only in the antero-posterior projection the increase of the total area of the hepatoscannogram at the expense of the increase of the length and thickness of the liver can be regarded as a statistically significant sign of the initial stage of liver cirrhosis, in scanning in the lateral and posterioanterior projections there were also revealed additional statistically significant tests of liver cirrhosis: decrease of the percentage the total area of the active zone of accumulation, and increase of

isotope accumulation in the spleen. There is an impression that the revealed signs correlate with the stage of the disease. (auth)

3864 RADIOISOTOPE DIAGNOSIS OF METASTATIC AFFECTION OF LYMPHATIC APPARATUS. Mechev, D. S.; Korolev, V. I. (Kiev Scientific-Research Inst. of Roentgen-Radiology Inst.). Med. Radiol.; 20: No. 4, 12-17(Apr 1975). (In Russian).

On the basis of observation made over 110 patients with four isotopes (colloid solution of ^{198}Au, microdispersed ^{198}Au, colloid solution of ^{111}In, ^{99m}Tc pertechnetate), the authors discussed the limits and possibilities of the methods of indirect radioisotope lymphography and lymphoscanning with ^{99m}Tc in the diagnosis of metastatic affections of cervical, axillary, paraaortic, inguinaliliac, and popliteal lymph nodes. It was noted that for indirect lymphography microdispersed ^{198}Au was the best isotope, however, with its use the percentage of diagnostic errors was rather high (20%). More valuable information was obtained in 35 patients with the use of ^{99m}Tc (accumulation of isotope in the affected lymph node, or in the group of lymph nodes and their reproduction on the scannogram). On the basis of their own experience the authors propose to combine two radioisotope methods during examination of patients: lymphoscanning with ^{99m}Tc and indirect lymphography with microdispersed ^{198}Au (first investigation with ^{99m}Tc and then in 2 to 3 days—with ^{198}Au). Information obtained in such a way will be of great help in complex examination of patients with metastatic affections of the lymph nodes. (auth)

3865 DIAGNOSTIC POSSIBILITIES OF RADIOISOTOPE SIALOGRAPHY. Stool, W.; Karl, A.; Unverricht, A.; Lauterbach, H. Med. Radiol.; 20: No. 4, 7-12(Apr 1975). (In Russian).

To perform radioisotope sialography, 300μ Ci of ^{99m}Tc was administered intravenously and then to stimulate salivation ascorbic acid was introduced. During investigations, the authors clarified the values of the sialogram parameters. It was shown that this simple method made it possible to study the function of accumulation and excretion of saliva. It is applicable for long-term investigations. During the first examinations it should be combined with scanning. The authors give clinical examples of the use of radioisotope sialography. (auth)

3866 RADIOISOTOPE MYELOCISTERNOSCINTIGRAPHY. Naumenko, Yu. I.; Zubovskii, G. A. (Moscow Scientific-Research Inst. of Roentgen-Radiology Inst.). Med. Radiol.; 20: No. 4, 3-7 (Apr 1975). (In Russian).

The method of radioisotope myeloscintigraphy with the help of albumin labelled with ^{131}I and the results of the application of this method in disorders of cerebrospinal fluid circulation and in processes accompanying compression of the spinal cord is described. The diagnostic value of the method in some forms of the spinal cord affection is shown. The illustrations show the possibility of obtaining a high quality picture of the cerebrofluid tract. (auth)

3867 COMPARISON OF SCANS AND ANGIOGRAMS IN SELECTING PATIENTS WITH HEPATOMAS FOR HEPATIC LOBECTOMY. Gammill, S. L. (Univ. of Tennessee, Memphis); Takahashi, M.; Jingu, K.; Stumpe, W.; Font, R. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 522-530 (Mar 1975).

The ^{99m}Tc sulfacolloid or ^{198}Au liver scans and selective hepatic and superior mesenteric arteriograms from 35 patients with hepatomas were evaluated as to accuracy in predicting operability or inoperability. The scans and angiograms agreed in 27 patients and were correct in 23 as to operability or inoperability of the tumors. They disagreed in eight cases. The angiograms were more accurate in predicting operability or inoperability than the scan in six cases; in two cases the scan accurately predicted inoperable tumor when the angiographic findings suggested that they were operable. The reasons for this discrepancy are discussed. (auth)

3868 ISOTOPE INEQUILIBRIUM OF GLUCOSE METABOLITES IN INTACT CELLS AND PARTICLE-FREE SUPERNATANTS OF EHRLICH ASCITES TUMOR. Daehnfeldt, J. L.; Winge, P. (Fibiger Laboratoriet, Lyngby, Denmark). Proc. Soc. Exp. Biol. Med.; 148: No. 4, 974-980(Apr 1975).

With an enzyme degradative technique, isotope inequilibrium of glucose metabolites was demonstrated in intact cells and particle-free supernatants of Ehrlich ascites tumor using 1-^{14}C-glucose as tracer. Inequilibrium was found between glucose and glucose-6-phosphate, glucose and fructose-6-phosphate, glucose and 6-phosphogluconate, while glucose-6-phosphate and fructose-6-phosphate were found to be in near-equilibrium within the incubation time investigated. Glucose and lactate were found to be in near equilibrium after 8 min in intact cells. Calculations based on the equilibrium levels found, showed that these inequilibria could not be explained by the effects of the pentose cycle. (auth)

3869 COMPARISON OF ^{99m}Tc COMPLEXES FOR RENAL IMAGING. Arnold, R. W.; Subramanian, G.; McAfee, J. G.; Blair, R. J.; Thomas, F. D. (State Univ. of New York, Syracuse). J. Nucl. Med.; 16: No. 5, 357-367(May 1975).

The distribution of 17 different agents for renal imaging was compared in the rabbit by organ radioassay at 1 hr. Similarly, ^{99m}Tc complexes of iron-ascorbate, glucoheptonate (GHA) and 2,3-dimercaptosuccinic acid (DMS), and ^{203}Hg-chlormerodrin were compared in the dog. The distribution of ^{99m}Tc-GHA and DMS was assessed in the human by blood and urinary clearance, external renal measurements, and scintillation camera imaging, and compared with older renal radiopharmaceuticals. Radiation dose estimates, based chiefly on human data, were calculated. Technetium-99m-DMS reaches a high concentration in the renal cortex and its urinary excretion rate and blood clearance are slow. It is excellent for imaging the renal parenchyma without activity in pelvocalyceal collecting system. However, it readily oxidizes and must be used within 30 min of preparation. The biologic distribution of ^{99m}Tc-GHA is similar to gluconate and iron-ascorbate complex. Its renal concentration is not as great as that of DMS but its blood and urinary clearances are much faster, resulting in lower radiation doses to most organs. Early camera images with this agent usually demonstrate both the renal parenchyma and collecting system. In later images, there is excellent demonstration of the parenchyma alone, superior to that obtained with ^{99m}Tc-Sn-DTPA. It is a very stable complex and may be used for at least 5 hr after preparation. All radioactive renal agents examined to date have a significant concentration in the liver, making an accurate quantitative comparison between the two kidneys difficult. (auth)

3870 EFFECT OF CONTRAST LYMPHANGIOGRAPHY ON LOCALIZATION OF ^{67}Ga-CITRATE. Lentle, B. C.; Castor, W. R.; Khaliq, A.; Dierich, H. (Cross Cancer Inst., Edmonton, Alberta). J. Nucl. Med.; 16: No. 5, 374-376(May 1975).

Oily lymphangiographic contrast material introduced prior to total-body ^{67}Ga-citrate scanning may be responsible for accumulation of the radionuclide within the lungs. The possibility of false-positive examinations suggests caution in the interpretation of the scan which evidences this finding. When possible, gallium scintiscans should be scheduled prior to contrast lymphangiography. (auth)

3871 TUMOR IMAGING AFTER ADMINISTRATION OF ^{99m}Tc-LABELED BLEOMYCIN. Mori, T.; Hamamoto, K.; Onoyama, Y.; Torizuka, K. (Kyoto Univ.). J. Nucl. Med.; 16: No. 5, 414-422 (May 1975).

Bleomycin, an anticancer drug, was labeled with ^{99m}Tc using stannous chloride and ascorbic acid and specific activities of 1 to 3 mCi/mg-eq with labeling efficiencies of 50 to 75 percent were achieved. Very rapid excretion of ^{99m}Tc-bleomycin through the kidney and concomitant rapid decrease of radioactivity in blood, various tissues and organs, and whole body were observed after intravenous administration of the radiopharmaceutical into tumor-bearing mice. In such animals, approximately 1 percent of the label was found in a transplanted fibrosarcoma within 30 min while 0.58 percent was recovered in such lesions even after 24 hr. In patients positive tumor images were obtained by scintigraphy as early as 1 hr after intravenous administration of 3 to 5 mCi of ^{99m}Tc-bleomycin. A total of 142 cases were examined by scintigraphy after administration of ^{99m}Tc-bleomycin and/or ^{67}Ga-citrate. In 93 cases with various malignant tumors, tumor was detected in 80 percent using ^{99m}Tc-bleomycin and in 63 percent using ^{67}Ga-citrate. Technetium-99m-bleomycin scintigraphy successfully detected tumors of the thyroid, lung, face, breast, extremity, and digestive tract and was also useful in finding metastatic lesions and brain tumors. However, ^{67}Ga scintigraphy gave superior results in detecting lesions in patients with malignant lymphomas. In patients with inflammatory diseases, accumulation in lesions was detected in 13 percent using ^{99m}Tc-bleomycin and in 48 percent using ^{67}Ga-citrate. The further use of ^{99m}Tc-bleomycin scintigraphy for tumor detection in patients appears to be warranted. (auth)

3872 AUGMENTED RADIOACTIVITY ON BONE SCANS OF LIMBS BEARING OSTEOSARCOMAS. Goldman, A. B.; Braunstein, P. (New York Univ.). J. Nucl. Med.; 16: No. 5, 423-424 (May 1975).

Thirteen patients with biopsy-proven osteosarcomas were studied with ^{99m}Tc-labeled bone-scanning agents. In addition to the dense areas of abnormal uptake corresponding to the tumors, ten patients exhibited a relative increase of radioactivity at the ends of the long bones of the affected extremities. Several of these areas were included in the surgical specimens but no tumor cells were found. (auth)

3873 COMPARISON OF $^{82}Rb^{+}$ AND $^{13}NH_3$ FOR MYOCARDIAL POSITRON SCINTIGRAPHY. Budinger, T. F.; Yano, Y.; Hoop, B. (Univ. of California, Berkeley). J. Nucl. Med.; 16: No. 5, 429-431 (May 1975).

Rubidium-82 (75-sec half-life) is eluted from a ^{82}Sr (25-day half-life) generator and infused into phantom and dog to show that it gives images of myocardial accumulation comparable to ^{13}N-ammonia with the positron camera. (auth)

3874 SCINTIGRAPHY WITH TECHNETIUM-99m (PERTECHNETATE) AS A DIAGNOSTIC METHOD IN THE EXAMINATION OF PATIENTS WITH UNILATERAL EXOPHTHALMOS. Stefanova, J. (Vissh Meditsinski Inst., Sofia (Bulgaria)). Oftalmologiya (Sofia).; 22: No. 1, 21-25(1974). (In Bulgarian).

A series of 20 patients with unilateral exophthalmos of non-endocrine origin were studied scintigraphically using ^{99m}Tc (pertechnetate). Delineation of the scintigraphy fields is performed by means of a lead mask 2 mm thick. Scintigraphy is carried out at 1, 3, and 6 hours after peroral administration of the isotope. In benign processes levelling of the activities of the two orbits is established at later terms, while in malignant processes the activity of the exophthalmic orbit predominates in the later hours. (auth)

3875 DETERMINATION OF mRNA HALF-LIFE IN HeLa CULTURES BY A POLY(A)–INDEPENDENT DIRECT ANALYSIS OF SPECIFIC RADIOACTIVITY OF mRNA. Wiegers, U.; Kramer, G.; Klapproth, K.; Rehpenning, W.; Hilz, H. (Hamburg Univ. (F. R. Germany). Inst. fuer Physiologische Chemie; Hamburg Univ. (F. R. Germany). Medizinische Dokumentation and Statistik). Eur. J. Biochem.; 50: No. 3, 557-562(Jan 1975).

4 figs.; 26 refs.

mRNA specific radioactivity in HeLa cultures exposed to [^{3}H]uridine(10 μM) was determined directly by a highly poly(A)-independent method. Neither uridine in mRNA nor UTP approached the specific radioactivity of the exogenous [^{3}H]uridine, but attained steady-state specific radioactivities, which remained a third below the value of the added precursor. Using the labelling data for the evaluation of mRNA turnover, mRNA half-life in exponentially growing HeLa cultures was found to be 0.87 x the cell doubling time. Decay curves of mRNA in prelabelled cultures were in accordance with these values (half-life = 0.79 x the cell doubling time) when corrected by growth. The experiments showed that an exact evaluation of mRNA turnover is possible only when the following points are taken into account: a) A constant supply of exogenous labelled uridine must be provided to guarantee a constant specific radioactivity of UTP. b) Labelling of CTP and of cytidine in RNA are delayed when compared with UTP and uridine in RNA. c) As rRNA approached a definitely lower steady-state specific radioactivity than mRNA, mRNA specific radioactivities must be determined directly in order to evaluate true turnover of this RNA species. (GE)

MATERIALS

3876 (CONF-740570-P2) 8th PLANSEE SEMINAR, REUTTE, AUSTRIA, MAY 27–30, 1974. Preprints. Volume II. (Metallwerk Plansee A. G., Reutte/Tyrol (Austria)). 1974. 353p. (In Several Languages).

In the volume, 28 papers are presented on various materials topics: alloys and ceramics, corrosion and wear resistance, hardened layers, refractory compounds, carbonitrides, cermets, composites, synthesis and deposition, etc. Separate abstracts were prepared for eleven papers. (DLC)

For abstracts of individual papers see: 3887–3895, 3991, and 3992.

3877 (CONF-740570-P3) 8th PLANSEE SEMINAR, REUTTE, AUSTRIA, MAY 27–30, 1974. Preprints. Volume III. (Metallwerk Plansee A. G., Reutte/Tyrol (Austria)). 1974. 48p. (In German and English).

The volume contains three papers: (1) high-strength and wear-resistant Co–Cr–C alloys produced by powder metallurgy (alloying with W); (2) plasma-sprayed coatings for high-temperature wear resistance (Mo deposition and properties); and (3) crack resistance improvement in mechanical and thermal properties of nonmetallic sintered materials (Al_2O_3–Nb). (DLC)

3878 (ORNL–5028) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1974. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 155p. Dep. NTIS $7.60.

Activities in research programs are summarized on electronic and magnetic properties of materials, crystal lattice dynamics, properties of solid surfaces, radiation effects on metallic materials, physics of insulating materials, neutron scattering, and properties of controlled-impurity materials. (JRD)

3879 ELECTRON PENETRATION OF HEAVY MATERIALS AT HIGH VOLTAGES UP TO 3 MV: THE CASES OF Au AND Ta. Roucau, C.; Ayroles, R. (CNRS, Toulouse). Phil. Mag.; 31: No. 2, 387-404(Feb 1975). (In French).

The problem of electron penetration in transmission electron microscopy is all the more acute as the atomic weight of the elements composing the observed materials is high. If the increase of electron energy is to contribute in increasing the penetrating power, it can be seen that the improvement is effective only for well-defined observing conditions. From the investigations carried out for accelerating voltages between 100 and 3000 kV, it follows that the crystal orientation with respect to the incident beam plays a leading part. As far as heavy materials, such as gold and tantalum are concerned, the results were used to determine the best penetration conditions. (auth)

3880 METAL-SEMICONDUCTOR CONTACTS. Conference Held at Manchester, England, April 3–4, 1974. Conference Series Number 22. New York; American Institute of Physics (1974). 268p. (CONF-740497-). $34.00.

Twenty-seven papers and two abstracts are arranged into six chapters on theory of metal-semiconductor contacts, Si and related compounds, hot carriers and heat sinks, Rutherford backscattering and other techniques, deep levels and Schottky barriers, and special topics. A separate abstract was prepared for one paper on the determination of deep trap levels caused by ion-implanted impurities. (DLC)

For an abstract of an individual paper see: 4126.

3881 PLAZMENNYE PROTSESSY V METALLURGII I TEKHNOLOGII NEORGANICHESKIKH MATERIALOV. (Plasma Processes in Metallurgy and Technology of Inorganic Materials). Paton, B. E. (ed.). Moscow; Izdatel'stvo nauka (1973). 245p. (In Russian).

In the 26 articles compiled, problems on the status and development of the theory of generating and using low-temperature plasmas are examined. Experimental studies of the last six years are generalized. Methods for the most rational use of plasmas in industrial technology are noted. The topics considered are plasma generation, processing procedures, metallurgy, coatings, composition materials, and the synthesis and reprocessing of inorganic materials. Separate abstracts were prepared for three articles. (tr-auth)

For abstracts of individual papers see: 3925, 3965, and 3966.

Ceramics and Cermets

Refer also to abstracts 3924, 3968, 4094, 4110, 4112, 4116, 5207, 5402, 5572, 5674, 5707, and 5714.

3882 (AED-CONF-74-538-037) CERAMIC-TO-METAL SEALING PROCESSES FOR HIGH OPERATING TEMPERATURES. Doerre, E.; Capelletti, C. M. (Fedlmuehle Kyocera Europa Elektronische Bauelemente GmbH, Plochingen, (F. R. Germany)). 1974. 7p. (In German). INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974). ●

7 figs.; 2 tabs.; 7 refs. With abstract. Special print. Published in DVS-Bericht v. 32.

Design, development, manufacture, bonding mechanism, and properties of alumina base ceramic-to-metal seals for high operating temperatures, and applications in the field of electronics and nuclear technology are discussed. (GE)

3883 (CONF-740570-P1, pp 1.1-1.24) PRINCIPLES OF THE WEAR OF ULTRAHARD INDUSTRIAL MATERIALS. Dawihl, W.; Altmeyer, G. (Univ. Saarlandes, Homberg, Ger.). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The principles are derived on the basis of a literature review. Among the materials discussed are aluminum oxide, zirconium oxide, silicon carbide, boron carbide, and hard metal (WC + 6% Co). It is shown that for the evaluation of the wear behavior of ultrahard materials it is necessary to characterize the materials not only by the hardness and stability but also to consider the notch effect and stress intensity factors and their temperature dependence. The formation of microcracks and the crack inhibition effect at the beginning of macroplastic deformation are of special importance. (13 figures, 9 tables, 23 references) (JSR)

3884 (CONF-740570-P1, pp 2.1-2.29) ISOSTATIC COMPACTING OF TUNGSTEN POWDERS AND METAL OXIDE–TUNGSTEN POWDER MIXTURES. Schob, O.; Geijtenbeek, J. J. F. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

After a brief review of some essential characteristics of isostatic compacting, experiments were described in which various W powders were isostatically compressed at 15,000 kg/cm^2 in a simple device. The density of the compacted powder before sintering is 86% of theoretical density on an average and reaches 92% of the theoretical density after sintering for one h at 2400°C. The interpretation of the results of the pressure-density studies was discussed on the basis of P-D relations reported in the literature. A new P-D relation was proposed which is valid over a larger pressure range than the literature relations. Some research results on the deformability and porosity of the isostatically compacted tungsten powder compacts and some aspects of shaping them were discussed. Studies on the isostatic compaction of W–Al_2O_3 and Mo–Al_2O_3 powder mixtures were also reported. (tr-auth)

3885 (CONF-740570-P1, pp D3.1-D3.5) ELECTRICAL AND CHEMICAL PROCESSES IN POROUS ARTIFICIAL CORUNDUM SINTERED ON A TUNGSTEN SURFACE. Hegedus, A. J.; Arato, A. (TUNGSRAM Forschungsinstitut, Budapest). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

Porous artificial corundum layers sintered on W were studied between 1000 and 1700°C by current–temperature, current–time, current–voltage, current–oxygen pressure, and current–hydrogen pressure measurements using W, Pt, and Ni counterelectrodes. Gas conduction, surface conduction, and volume conduction could be distinguished. It could be established when and how the W penetrated the corundum frit, in which surface layer its crystallites were formed, and why the layer would be p-conducting at one time and n-conducting at another. An hypothesis was developed

to explain the conduction and breakdown processes occurring. (tr-auth)

3886 (CONF-740570-P1, pp D6.1-D6.5) FORMATION OF CARBIDES IN THE SYSTEM Mo–(Ni + C). Rieck, G. D.; Heijwegen, C. P. (Univ. of Technology, Eindhoven, Netherlands). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The problem of a diffusion couple of Mo with Ni containing 0.06 and 0.4% C was studied. The two-phase layers which formed above 1000°C were found to be Mo_4Ni_2C and Mo_6Ni_6C. Growth of the layers and the stages were studied. (DLC)

3887 (CONF-740570-P2, pp 31.1-31.35) MIXED CARBIDES AND CARBONITRIDES OF Ta AND Hf AND THEIR REACTION WITH POSSIBLE BONDING METALS. Holleck, H.; Komac, M.; Ritzhaupt-Kleissl, H. J.; Scholz, B.; Schneider, H.; Thuemmler, F. (Univ., Karlsruhe, Ger.). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

The structure of Ta–Hf–C, Ta–Hf–N, Ta–C–N, Ta–Hf–C–N, Ta–Mo–C, and Ta–W–C systems was briefly described. The hardness pattern in these systems were determined as a function of the carbide content and the temperature. The mixing and precipitation processes occurring in these carbides and carbonitrides were determined and their effect on the hardness was evaluated. Their interaction with Ni, Co, Inconel 713C, ATS 113, stainless steel 306 L, and NiMo 30 used as bonding metals was outlined. Results showed that precipitation processes led to no increase in the hardness. Interaction with the binding metal occurred only when it could be incorporated into the mixed carbide or carbonitride lattice. (JSR)

3888 (CONF-740570-P2, pp 32.1-32.15) CEMENTED CARBIDES WITH HIGH MELTING-POINT PRECIOUS METAL BINDER PHASES. Jackson, J. S. (Production Tool Alloy Ltd., Bedford, Eng.); Warren, R.; Waldron, M. B. 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

A study was made of alloy systems consisting of TiC and WC in combination with Ru and Ru–Pd alloys. Particular attention was paid to alloys with high carbide contents which have a potential application as cutting tool materials. The alloys were successfully prepared using conventional powder metallurgical techniques. Alloys based on the TiC–Ru system were found to be particularly promising in preliminary machining tests. In this system it was found that small amounts of the metals, nickel, cobalt, or iron, which are normally picked up during milling, are necessary for the full densification of the alloys at convenient sintering temperatures (i.e., about 1500°C). A more detailed study of TiC–(Ru, Ni) alloys showed that the small amount of nickel required for effective sintering does not seriously affect the properties of the alloy and that, with this quantity of nickel, the melting point of the binder phase is still significantly higher than that of conventional cemented carbides. (8 fig) (auth)

3889 (CONF-740570-P2, pp 35.1-35.7) FACTORS INFLUENCING THE PERFORMANCE OF SINTERED CARBIDES UNDER ARDUOUS CONDITIONS OF ROLLING CONTACT. Scott, D. (National Engineering Lab., East Kilbride, Scotland). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

Using an accelerated service simulation test, the performance of sintered carbides under arduous conditions of unlubricated and elevated temperature rolling contact was assessed and compared with that of conventional ball bearing materials and other potential wear-resistant materials. Metallurgical and electron-microscopical investigation provided information for elucidation of failure mechanisms and their controlling factors. Under test conditions, sintered tungsten carbide was superior to the other materials tested unlubricated at both ambient and elevated temperature. Grain size of the carbide as well as the amount of matrix material can have a considerable influence on performance and on the wear mechanism of failure. (auth)

3890 (CONF-740570-P2, pp 36.1-36.11) LATEST DEVELOPMENTS IN THE NITRIDE CHEMISTRY OF THE TRANSITION METALS. Kieffer, R.; Ettmayer, P. (Technische Hochschule, Vienna). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

A review is given of the latest experimental results on the nitridation of the transition metals. The metals discussed are Ti, Zr, Hf, V, Nb, and Ta. The preparation of the nitrides, their melting points, and sintering procedures are described. The bending strength and hardness of TiN–TiC and TiN–TiC–TaN with various bonding materials are tabulated. (JSR)

3891 (CONF-740570-P2, pp 38.1-38.19) PREPARATION OF HAFNIUM CARBIDE BY VAPOR-PHASE CHEMICAL DEPOSITION. Hertz, D.; Spitz, J.; Besson, J. (CEN, Grenoble, France). 1974. (In French).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

The preparation of HfC by reaction of $HfCl_4$ and CH_4 in an atmosphere of hydrogen and deposition of the HfC on substates of graphite, Mo, WC–Co cermets, and HfC frits was studied to determine the effect of temperature and C/Hf ratio on the quality of the deposit. Results showed that the adhesion is excellent when the carbide contains no free C. The porosity was very low and the hardness varied with the nature and composition of the material deposited. It was also determined that the presence of hydrogen is necessary to avoid premature decomposition of the methane. The conditions for the preparation of stoichiometric HfC were determined. (JSR)

3892 (CONF-740570-P2, pp 39.1-39.15) SYNTHESIS, STRUCTURE, AND SOME PROPERTIES OF THE COMPOUNDS ZrB_xN_{1-x} AND TiB_xN_{1-x}. Cantarel, J. Y. (Ecole Nationale Superieure de Chemie, Toulouse); Pastor, H.; Meyer, R.; Montel, G. 1974. (In French).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

Three methods were used to obtain homogeneous ternary phases of (Ti, Zr)–B–N at temperatures below 1300°C. These phases with a fcc structure have a lattice parameter which increases with the B content. Their formula, determined by chemical analysis, is close to (Ti, Zr) $B_{1-x}N_x$. By hot compression at 2000°C under vacuum for an hour, it is possible to prepare dense composites of TiB_2–TiN_xB_ϵ ($x < 1$ and $\epsilon \simeq 0$) in the triangular region TiB_2–$TiN_{0.44}$–TiN of the ternary Ti–B–N system. These composites are remarkable for their hardness and high resistance to wear, oxidation in air at 1000 to 1200°C, and acid attack. (10 figures) (tr-auth)

3893 (CONF-740570-P2, pp 43.1-43.5) SINTERING, STRUCTURE, AND PROPERTIES OF ALUMINA–TUNGSTEN CERMETS. Kisly, P. S.; Storozh, B. D. (Inst. of Materials Problems, Kiev). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

The activation energy of the process was determined and the mass transfer mechanism elucidated. The motion and annihilation of linear defects take place in the first stage of sintering; in the second stage, the consolidation is limited by the volume and boundary self-diffusion. The free surface energy of tungsten (2790 MJ/m^2), the boundary free energy of tungsten (2080 MJ/m^2), and the surface energy at the tungsten–alumina boundary (2250 MJ/m^2) were determined which provided information on the processes of liquid phase sintering and formation of a definite microstructure. Investigation of the strength properties of cermets and micrographs of fracture surface led to the conclusion that a strong bond is formed between the ceramic and metallic phases in alumina–tungsten cermets. (auth)

3894 (CONF-740570-P2, pp 44.1-44.12) CORROSION AND WEAR-RESISTANT MATERIALS WITH A MOLYBDENUM–METAL OXIDE BASE. Heitzinger, F. (Metallwerk Plansee AG. and Co., Reutte, Austria). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

Knowledge of the corrosion in liquid Fe and the oxidation in air of Mo + ZrO_2 and Mo + Al_2O_3 cermets is of great importance in considering their use as protection tubes in Fe melts. The solubility rate of these two cermets in steel and cast iron was discussed. The oxidation wear was then considered and the high resistance of Mo + ZrO_2 cermets was emphasized. (tr-auth)

3895 (CONF-740570-P2, pp 45.1-45.22) HIGH-MELTING METAL–CERAMIC EUTECTIC. Claussen, N.; Petzow, G.; Jahn, J. (Max-Planck-Institut fuer Metallforschung, Stuttgart). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. II.

The fracture behavior of a series of high-melting metal–ceramic eutectics (ZrO_2–Ta, ZrO_2–W, $(Cr, Al)_2O_3$–Cr, Cr_2O_3–Mo, Al_2O_3, Cr_2O_3, and Gd_2O_3–Mo) was investigated in notched samples in which the metallic phase was deposited as a thin fiber. Methods of preparation of the samples were described in detail. Mechanisms for the quasiductile behavior of many of the metal–ceramic eutectics were discussed. (JSR)

3896 (JUL-1160) NIOBIUM HYDROGEN SYSTEM: AN ELECTRON MICROSCOPE STUDY. Part I. Room Temperature Results. Part II. Low Temperature Structures. Schober, T. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). Jan 1975. 44p. Dep. NTIS (US Sales Only) $5.25.

The room-temperature morphology of β- and δ-phase precipitation in the NbH system was investigated under ultrahigh purity conditions (uhv degassed Nb and electrolytic charging). The β-phase ($NbH_{0.7}$ in the two-phase region) precipitated after electrolytic charging at room temperature in the form of large, dendritic particles. Charging at 150°C mainly resulted in plates on {100}. The presence of domain boundaries, antiphase boundaries, and twins in such precipitates was demonstrated. Evidence for extensive plastic deformation in β-phase areas was obtained and possible reasons for this are discussed. δ-phase (fcc NbH_2) precipitation occurred in the form of plates on {210} inside the β-phase. Observations are presented on the β- and δ-phase morphology for concentrations of up to 200% (= H/Nb). The main reasons for hydrogen embrittlement in highly charged NbH samples are described. The structure and morphology of low-temperature hydride phases were investigated. Quenching of dilute alloys produced small hydride particles which emitted interstitial dislocation loops into the matrix. Irreversible dislocation "skeletons" were generated when such hydride precipitates were thermally dissolved. Three ordered solutions were observed: the β-phase above −45°C, the ζ-phase from −45 to −65°C, and the ϵ-phase below −65°C. The reciprocal lattices of ζ and ϵ were determined. The ϵ-phase is identical with the hydride Nb_4D_3 found by Somenkov. ζ and ϵ are orthorhombic with the same lattice parameters as β. (18 fig) (auth)

3897 (KFK-2098) SUPERCONDUCTING THORIUM COMPOUNDS UNDER HYDROSTATIC PRESSURE. Dietrich, M. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nov 1974. 67p. (In German). Dep. NTIS (US Sales Only) $6.50.

Thesis. Submitted to Karlsruhe Univ., West Germany.

Pressure experiments on superconducting thorium compounds were made up to 28 kbar. The transition temperature was determined by the change in susceptibility, the pick-up coil being located within the fluid pressure medium. For Th_4H_{15} and Th_4D_{15} with T_c's of about 7.6°K, the increase in T_c with pressure was +42 mK/kbar, whereas a separate phase of Th_4H_{15} with the same lattice constant and a T_c of 8.6 K had an increase of +53 mK/kbar. The values for the carbonitrides of thorium in mK/kbar are: ThN = −14.6; $ThC_{0.45}N_{0.55}$ = −2.7; $ThC_{0.6}N_{0.4}$ = +3.5; $ThC_{0.8}N_{0.2}$ = +7.6. The carbonitrides of thorium show some similarities with refractory materials; such an analogy between thorium hydride and the hydrides of the other transition metals is absent. The superconducting properties of the investigated compounds are explained by additional scattering of the conduction electrons at the light nonmetallic elements. (15 figures, 70 references) (auth)

3898 (ORNL-tr-2883) PROPERTIES OF EUROPIUM OXIDES. Balaev, R. A.; Bondarenko, V. V.; Vyskubov, V. P.; Kiparisov, S. S.; Lazarevski, V. A.; Tyugin, V. M. 1974. Translation of Svoistva Okislov Evropiya, Atomizdat, Moscow, 1974. 48p. Dep. NTIS $5.50.

Data on the application, separation, and properties of the europium oxides such as EuO_3, EuO, and Eu_3O_4 are presented. The crystallographic, thermodynamic, thermophysical, electrophysical, magnetic, mechanical, and chemical properties of europium oxides are discussed along with their radiation stability and dispersion materials based on them. (auth)

3899 (RD/B/N-3225) INTERPRETATION OF THE MECHANISM OF CREEP IN POLYCRYSTALLINE URANIUM CARBIDE. Burton, B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Dec 1974. 10p. Dep. NTIS (US Sales Only) $4.00.

Previously reported creep data on polycrystalline UC and nickel doped UC are reinterpreted. It is shown that the apparently complex behavior can be rationalized in terms of a diffusional creep model modified to include a term associated with the ease at which grain boundaries emit and absorb vacancies. This term is shown to vary with temperature and dopant concentration. (auth)

3900 (WANL-TMI-1787) DEVELOPMENT OF PRELIMINARY CREEP DATA FOR CARBIDE COMPOSITES. Malarky, J. T. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jan 1968. 5p. Dep. NTIS $4.00.

Tests were conducted to develop preliminary creep data for NbC and TaC composite specimens analogous to the reactor cluster element end and aft end support pedestal interface. These data were obtained to show whether the pedestal can withstand high stresses caused by unequal cluster element lengths and provide design bases for carbide composite material at variant temperatures and stresses. Results of preliminary tests show that NbC composite material will not crack, creep excessively, or experience coating spalling at 4800°R when subjected to nominal stresses (4500 psi) which could occur due to unequal fuel element length. However, the results also show variance between samples supplied by manufacturers and a need for variant temperature creep testing to determine the carbide composite maximum temperature and stress capabilities. Specimens are being obtained for more complete creep testing from 4300 to 5000°R and stresses of 2000 psi to 8000 psi to develop reliable design data on the carbide composite materials. (auth)

3901 MANUFACTURE OF NUCLEAR FUEL. Price, M. S. T. British Patent 1,375,371/B/. 27 Nov 1974. 2p.

A manufacturing process is described for nuclear fuel in oxide form. The starting material is UO_2F_2 powder which is agglomerated to spheroidal or other required shapes and converted to substantially fluoride-free oxide by heat treatment in an atmosphere containing steam or steam and hydrogen. Steam alone produces U_3O_8, while steam and hydrogen produce UO_2. The heat treatment is carried out at 700 to 800°C. The product is generally required in spheroidal shape with diameter up to 1500 μm, suitable for coating with fission product retaining material. The UO_2F_2 is produced from UF_6 gas by reaction with steam in fluidized bed apparatus, and the overall process is cheaper than the conventional process. (UK)

3902 TERNARY SYSTEM Na_2O–B_2O_3–V_2O_5. Mal'tsev, V. T.; Kryzhanovskaya, L. G.; Cherpillo, V. P.; Volkov, V. L.; Matrosova, V. A. (Rostov Engineering Construction Inst., USSR). Ukr. Khim. Zh.; 41: No. 1, 30-34 (Jan 1975). (In Russian).

The ternary system Na_2O–B_2O_3–V_2O_5 was studied by visual-polythermic, thermographic, and x-ray phase methods. The fields of primary crystallization of the initial components and compounds formed on the two sides were shown. The Na_2O–B_2O_3–V_2O_5 system is characterized by formation of a ternary congruently melting compound with the probable composition $Na_2O{\cdot}6B_2O_3{\cdot}3V_2O_5$. (tr-auth)

3903 ULTRASONIC TREATMENT OF TRANSITION METAL CARBIDES. Paustaovskii, A. V.; Verkhoturov, A. D.; Naumenko, V. Ya. Fiz. Khim. Obrab. Mater.; No. 1, 123-126(1975). (In Russian).

A study was made of the regularities in the disruptions of carbides of group IV-VI metals under ultrasonic treatment. Correlations were established between the treatment efficiency and a series of mechanical characteristics of the compounds and features of electron structure (brittleness, modulus of elasticity, microhardness, the degree of localization of the valence electrons of the carbide-forming element). The following carbides were studied: TiC, ZrC, HfC, VC, NbC, TaC, Cr_3C_2, Mo_2C, and WC. Workability of the carbide is conditioned by two competing factors: brittleness and hardness. Carbides of group V metals (VC, NbC, TaC) which have a high brittleness in comparison with group VI metal carbides (Cr_3C_2, Mo_2C and WC) and a lower hardness in comparison with the group IV carbides (TiC, ZrC, HfC) have the greatest workability. (SJR)

3904 MELTING BEHAVIOR OF YTTRIUM ORTHOVANADATE. Ropp, R. C. (Allied Chemical Corp., Morristown, NJ). Mater. Res. Bull.; 10: No. 4, 271-275(Apr 1975).

When YVO_4 melts at 1810°C, it decomposes to form YVO_3, a black semi-conducting compound. Between about 1500°C and its melting point, YVO_4 also reacts to form $Y_8V_2O_{17}$ plus V_2O_5. The melt actually consists of a ternary system whose composition changes with time. Reoxidation of YVO_3 to YVO_4 can be accomplished below the melting point by annealing in oxygen. The difficulty in obtaining high-quality optical crystals of YVO_4 by Czrochralski growth is thus explained. (auth)

3905 CHARACTERISTICS OF YLaTm-GARNET FILMS FOR MAGNETIC BUBBLE APPLICATIONS. Smith, A. B.; Kestigian,

M.; Bekebrede, W. R. (Sperry Research Center, Sudbury, MA). Mater. Res. Bull.; No. 4, 303-311(Apr 1975).

Films of $Y_{1-x}La_{x-3}Tm_{1-1}(FeGa)_5O_{12}$ were grown by liquid-phase epitaxy on $Gd_3Ga_5O_{12}$ substrates. This is a new film composition whose high mobility (approximately 1000 cm/s/Oe) and low temperature coefficient of bubble diameter (approximately 0.1 percent/°C) make it attractive for bubble domain devices. Films supporting 3 to 8 mu m-diameter bubbles were prepared with typical defect densities less than 5/cm^2. Data are presented to show that this material can be grown reproducibly despite a rather large La segregation coefficient. Measurements of the uniaxial anisotropy as a function of lattice mismatch are presented along with the results of ion implantation studies which show that a dosage of 3×10^{13} cm^{-2} of Ne is sufficient to suppress hard bubbles in this material. Also, bubble velocity measurements are discussed in detail as they reveal a number of interesting effects. These include the existence of a perpendicular velocity component which can be virtually eliminated by applying an in-plane field and the absence of extreme dynamic conversion effects in high gradient fields. (auth)

3906 MAGNETIC PROPERTIES OF Gd_2O_3. Moon, R.M.; Koehler, W.C. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. B 11: No. 4, 1609-1622 (15 Feb 1975).

Polarized-neutron experiments have been used to measure the temperature dependence of the susceptibility of the Gd^{3+} ion at the two different crystallographic sites in cubic Gd_2O_3 in the paramagnetic state. Below 10°K these susceptibilities are quite different because of the different net exchange interactions with the rest of the crystal. The temperature dependences of the first- and second-neighbor spin correlations have also been observed through measurement of the diffuse scattering of unpolarized neutrons. An approximate theory of the magnetic behavior of Gd_2O_3 in the paramagnetic region is presented which provides predictions of the susceptibilities, spin correlations, and specific heat which are in reasonable accord with experimental results. The previously reported paramagnetic form factor for Gd_2O_3 has been revised slightly, leading to the conclusion that there is no convincing evidence supporting a difference in the 4*f* spin density between the metallic and oxide cases. (auth)

3907 HIGH-CONTRAST OPTICAL STORAGE IN VO_2 FILMS. Balberg, I.; Trokman, S. (The Racah Institute of Physics, The Hebrew University of Jerusalem, Israel). J. Appl. Phys. 46: No. 5, 2111-2119 (May 1975).

When vanadium dioxide, VO_2, undergoes its semiconductor-to-metal transition at 68°C its reflectivity decreases by about a factor of 2 throughout the visible range. By using a thin VO_2 film on a vanadium substrate we were able to achieve a much higher contrast between the reflectivities of the two VO_2 phases. The VO_2 film was grown as an antireflecting coating for one of the phases and thus the film thickness was used to determine the light wavelength at which the contrast will reach its maximum value. For example, with an 800-Å-thick film a contrast of 16 (rather than 2) was obtained at a light wavelength of 7000 Å. In utilizing the present system for optical storage the high contrast obtained yielded an order of magnitude higher read-out efficiency than the efficiency reported for VO_2 films sputtered on glass. To demonstrate information recording in the present system, both a pulsed laser and a cw laser were used for spatially selective"writing" in the film. It was found that the present system has high "write sensitivity" with a threshold, easy erasability, and high-resolution capability. Cyclic operation without fatigue and the convenience of using the same cw laser for both writing and reading, are other advantages of the system described. (auth)

3908 METHOD FOR PREPARING STABILIZED CUBIC ZIRCONIUM DIOXIDE. Pokhodenko, V. N.; Tselik, I. N.; Kopylov, G. A.; Filatov, L. Y.; Larichkin, E. A.; Mikhnevich, V. I.; Eroshin, P. K. (to Laboratorii Instituta Obschei i Neorganicheskoi Khimii Akademii Nauk Ukrainskoi SSR V Gorode Odesse). British Patent 1,368,842/B/. 2 Oct 1974. Filed date 23 Nov 1970. 3p.

Whereas monoclinic ZrO_2, as prepared industrially, cannot be used as a refractory since at about 1060°C it changes to a tetragonal crystal structure with marked volume changes, it has been found that cubic ZrO_2 is refractory to above 2500°C and is chemically resistant to the action of metals, slags and acids. Disadvantages of previous methods of preparing stabilized ZrO_2 are stated, and a method for preparing stabilized ZrO_2 that it is claimed mitigates these disadvantages is described. Basic Zr carbonate is mixed with a stabilizing additive comprising a Ca compound and the mixture is calcined. The basic carbonate preferably has the composition $Zr_2O(OH)_4CO_3$ and is mixed with the stabilizing additive as an aqueous pulp, followed by filtering and calcining at 700 to 800°C. The additive may comprise CaO or $CaCO_3$. (UK)

3909 HIGH TEMPERATURE BEHAVIOR OF In_2O_3. De Wit, J. H. W. (Univ. of Utrecht). J. Solid State Chem.; 13: No. 3, 192-200(Mar 1975).

The electrical conductivity of In_2O_3 was measured up to 1400°C in air. The temperature dependence of the conductivity at high temperatures yields an activation energy of 1.5 +- 0.1 eV. This activation energy is interpreted in terms of a nonstoichiometric decomposition of the compound. This interpretation is sustained by thermogravimetric analysis in combination with a gas mass analyzer. Hall experiments on quenched samples are not in contradiction with this interpretation. (auth)

3910 PHASE RELATIONS, DOPANT EFFECTS, STRUCTURE, AND HIGH ELECTRICAL CONDUCTIVITY IN THE Na_2WO_4–Na_2MoO_4 SYSTEM. Bottelberghs, P. H.; van Buren, F. R. (Univ. of Utrecht). J. Solid State Chem.; 13: No. 3, 182-191(Mar 1975).

The x, T-phase diagram of the binary system Na_2WO_4–Na_2MoO_4 was redetermined at ambient pressure, taking into account the influence of hysteresis effects. Thermodynamic calculations, based upon transition entropies as determined by precision DSC (differential scanning calorimetry), indicate that the system is almost ideal with respect to the high-temperature phases. As anion dopes, Na_2SO_4 and Na_2CrO_4 give a metastable extension of the beta-phase of Na_2WO_4 at decreasing temperature, involving some 40°C at 0.01 mole fraction of dopant. Cation dopes like Li_2WO_4 and K_2WO_4 behave quite differently. The electrical conductivity through the phase diagram is high in the alpha-phase (sigma approximately 10^{-2} mho cm^{-1}) almost regardless of composition. The anomalous high conductivity of the beta-phase decreases with increasing molybdate content. In pure Na_2MoO_4, an anomaly occurs at the alpha-alpha$_2$ transition, resembling the behavior of Na_2WO_4 at the beta-alpha transition. The (highest) alpha$_2$-phase is hexagonal, ($P6_3/mmc$), showing large anisotropic thermal vibrations. The alpha-phase is orthorhombic (Fddd) as is the beta-phase (probably $Pbn2_1$). (11 figures) (auth)

3911 CHEMICAL STABILITY OF ZIRCONIUM CARBIDE AND OXYCARBIDES AND PHASE CHEMICAL ANALYSIS OF THEIR MIXTURES. Kutysheva, E. V.; Kosolapova, T. Ya. (Inst. of Problems in Materials Science, Kiev). Ukr. Khim. Zh.; 41: No. 1, 88-91(Jan 1975). (In Russian).

The stability of zirconium carbide, oxycarbides, and dioxide in acids, their mixtures, and solutions with oxidizers and complex formers was studied. It was shown that the chemical properties of zirconium oxycarbides strongly depend on their oxygen content. With increase in the oxygen content, the stability of the oxycarbides greatly increases in solutions having oxidizing properties. A method for separating the components of the mixture $ZrC_x + ZrC_xO_y + ZrO_2(C)$ is proposed. (tr-auth)

3912 DOUBLE MOLYBDATES WITH PALMIERITE STRUCTURE. Efremov, V.A.; Trunov, V.K. (M. V. Lomonosov Moscow State University). Sov. Phys.—Crystallogr. 19: No. 5, 613-615 (Mar 1975).

The crystal structure of the double molybdate of potassium and lanthanum with the composition $K_3La(MoO_4)_4$ was determined (R_{hkl} = 11.2%). It was shown that it is isostructural with palmierite $K_2Pb(SO_4)_2$ and barium vanadate $Ba_2(VO_4)_2$. Data on the compounds isostructural with palmierite are classified. (auth)

3913 DOUBLE TUNGSTATES OF LITHIUM AND RARE EARTH ELEMENTS. Trunov, V.K.; Evdokimov, A.A. (M. V. Lomonosov Moscow State University). Sov. Phys.—Crystallogr. 19: No. 5, 616-617 (Mar 1975).

The double tungstates of lithium and rare earth elements (TR) were investigated by x-ray diffraction analysis and differential thermal analysis. New modifications, isostructural with γ-LiEr tungstate, were obtained for the Eu, Gd, Yb, Lu, and Y compounds. The relationships involved in the variation of the properties of these compounds are demonstrated on the basis of the obtained data and analysis of the published data. (auth)

3914 CRYSTAL STRUCTURE OF $Na_2[(UO_2)SiO_4]$. Shashkin, D.P.; Lur'e, E.A.; Belov, N.V. Sov. Phys.—Crystallogr. 19: No. 5, 595-597 (Mar 1975).

Sodium uranyl silicate $Na_2[(UO_2)SiO_4]$ was synthesized. The main interplanar separations are as follows, Å: 4.58(9); 4.47(9); 2.60(10); 1.749(9); 1.719(9); 1.702(9); 1.500(8); 1.381(8). They were obtained on an RKU-114 camera. The tetragonal lattice has the following parameters: a=12.718, c=13.376, c'=c/2=6.688 Å. Space group $I4_1/acd$, Z=16, ρ_x=4.85, ρ_x=5.06 g/cm^3. (auth)

3915 COMMENTS ON THE MECHANISM OF SELF-DIFFUSION OF CARBON IN HYPERSTOICHIOMETRIC URANIUM

CARBIDE. Murch, G. E. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). J. Nucl. Mater.; 55: No. 3, 355-356(Mar 1975).

An equation for the tracer carbon diffusion coefficient is given including the path probability of defects. (auth)

3916 THE LATTICE PARAMETERS OF $U_{0.8}Pu_{0.2}(C,N)$. Benedict, U.; Richter, K. (Commission of the European Communities, Karlsruhe (F. R. Germany). European Inst. for Transuranium Elements). J. Nucl. Mater.; 55: No. 3, 352-354(Mar 1975).

Lattice parameter measurements on mixed (U, Pu) carbonitrides with a Pu/(U + Pu) ratio of 0.20 are described, and a comparison is made with the measurements made by other investigators on U(C,N) and $U_{0.85}Pu_{0.15}(C,N)$. (auth)

3917 A DILATOMETRIC STUDY OF THE SOLUBILITY OF U_4O_9 IN UO_2. Bannister, M. J.; Buykx, W. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights. Materials Div.). J. Nucl. Mater.; 55: No. 3, 345-351(Mar 1975).

Phase relationships in the system $UO_2-U_4O_9$ were studied using a dilatometer in which the O/U ratio of a UO_{2+x} specimen could be both controlled and measured. Phase boundary temperatures were indicated by changes in expansion or contraction rate during heating or cooling, respectively. The solubility of U_4O_9 in UO_2 agreed with the results of previous workers using other techniques. The dependence of solubility on temperature is complex, and appears to be influenced by a high-temperature phase transition in U_4O_9. (auth)

3918 STRUCTURAL CHANGES IN UO_2-PuO_2 DURING CREEP. Vollath, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). J. Nucl. Mater.; 55: No. 3, 335-344(Mar 1975). (In German).

A review is given of possible structural changes of $(U,Pu)O_2$ taking place during the creep process. While grain growth is predominantly observed in the range of transient creep, a very slow reduction in density was found in the range of steady-state creep. It was also shown that events characterized by a very slow modification of the sample structure exert a strong influence on the determination of the stress exponent. (auth)

3919 CREEP BEHAVIOR OF LOW-DENSITY URANIUM CARBIDE-BASE ALLOYS. Seltzer, M. S.; Wright, T. R.; Speidel, E. O. (Battelle Columbus Labs., Ohio (USA)). J. Nucl. Mater.; 55: No. 3, 327-334(Mar 1975).

Compression creep tests were performed on 75% dense specimens of $UC_{1.01}$, $UC_{1.01}$ + 4 wt% W and $U_{0.9}Zr_{0.1}C_{1.01}$ + 4 wt % W, and on 85% dense specimens of the latter two compositions. Tests were conducted at 1400 and 1550°C in a vacuum of 6.65×10^{-4} N/m^2 (5×10^{-6} torr). All data could be fit by an expression of the form: $\dot{\epsilon} = A\sigma^n \exp - Q_c/RT$ where $\dot{\epsilon}$ is the creep rate, A is a constant, σ is the applied stress, n is the stress exponent, Q_c is the creep activation energy, and T is the absolute temperature. Values for the stress exponent were in the range $1.3 < n < 2.3$ while Q_c varied from 23.1 to 79.6 kcal/mol. (auth)

3920 RADIATION EFFECTS ON THE LATTICE CONSTANTS OF SINGLE CRYSTAL Al_2O_3. Roof, R. B. Jr.; Ranken, W. A. (Los Alamos Scientific Lab., N. Mex. (USA)). J. Nucl. Mater.; 55: No. 3, 357-358(Mar 1975).

The results of comparative measurements of neutron-induced changes of macroscopic and lattice parameter dimensions of single crystal Al_2O_3 are given for irradiation temperatures and neutron fluences higher than those for which similar data have previously been reported. (auth)

3921 THE KINETICS OF THE C → B TRANSFORMATION IN EUROPIUM SESQUIOXIDE. Ainscough, J. B.; Moore, D. A.; Osborn, S. C. (UKAEA Reactor Group, Springfields). J. Nucl. Mater.; 55: No. 2, 229-232(Feb 1975).

The C → B transition of europia in air can be described quite closely by first-order kinetics but the normal Arrhenius equation requires the inclusion of an additional term which has the effect of bringing the rate constant to zero at the transition temperature. The transition temperature is calculated to be 1074 ± 5°C. A limited study of the transition in hydrogen shows the extent of conversion in 2 h to be reduced relative to that which takes place in air. If first-order kinetics and the absence of an induction period are assumed, it can be shown that the activation energy for transformation is much greater in hydrogen than in air. This is tentatively ascribed to hypostoichiometry in the europia rather than to formation of Eu_3O_4. (auth)

3922 THERMODYNAMIC STUDY OF THE SYSTEM U–O–C BY MEASUREMENT OF THE EQUILIBRIUM PRESSURE OF CARBON MONOXIDE. Heiss, A. (Paris-11 Univ., 91 - Orsay (France). Lab. de Chimie Thermodynamique). J. Nucl. Mater.; 55: No. 2, 207-223(Feb 1975). (In French).

Reactions in UO_2/graphite mixtures, leading to carbon monoxide evolution, was investigated. Isotherms were established in the range 1720–1870°C, representing CO pressure as a function of O/U and C/U ratios. Mono- and bivariant equilibrium pressures and phase diagrams are established. This has made it possible to deduce the composition of the solid phases at high temperatures. The UO_2 phase contains a few vacancies while UC_2 (in equilibrium with UO_2 and C) does not, but contains 0.06 at % of oxygen substituted for carbon. UC_2 in equilibrium with $UO_{1.97}$ and U(C,O)is strongly hypostoichiometric and contains little oxygen ($UC_{1.83}O_{0.03}$); the monoxycarbide, hyperstoichiometric, has the formula $UC_{0.85}O_{0.10}$. A maximum oxygen solubility of 25% in UC is observed. From these results, the free energies of formation, ΔG_f^0, were calculated for $UO_{1.97}$, $UC_{1.94}O_{0.06}$, $UC_{1.92}O_{0.06}$, $UC_{1.91}$, $UC_{1.83}O_{0.03}$, $UC_{1.66}$, $UC_{0.95}O_{0.1}$, UC and $UC_{0.75}O_{0.25}$. (auth)

Metals and Alloys

3923 (CONF-740570-P1) 8th PLANSEE SEMINAR, REUTTE, AUSTRIA, MAY 27–30, 1974. Preprints. Volume I. (Metallwerk Plansee A. G., Reutte/Tyrol (Austria)). 1974. 391p. (In Several Languages).

Twenty-nine papers and abstracts are presented on various metallurgical topics: wear resistance, compacting, sintering, refractories and alloys, deposition, recrystallization, mechanical properties, structure, welding, powder metallurgy, dispersion strengthening, superalloys, etc. Separate abstracts were prepared for 19 of the papers. (DLC)

For abstracts of individual papers see: 3883–3886, 3953–3962, and 3986–3990.

3924 (ORNL-TM-4878) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1974. Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. 170p. AT.

Activities in research programs are summarized on advanced absorber materials, steam generator materials, and mechanical properties and fabrication of reactor structural materials. (JRD)

3925 DYNAMICS OF ARC SPOTS ON TUNGSTEN RODS IN HYDROGEN. Yukhimchuk, S. A.; Bolotov, A. V. pp 55-58 of Plazmennye Protsessy v Metallurgii i Tekhnologii Neorganicheskikh Materialov. Paton, B. E. (ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The effect of dynamic processes in the region close to the electron on the erosion of W electrodes was examined. It was found that the transition of the current through zero and the abrupt movement of the arc spots on the electrode surface with temperatures below ~2000°C lead to a sharp oscillation of the temperature of the spot and of its dimensions. Rapid cooling of the spot during transition of the current through zero creates conditions for the appearance of autoelectron and thermoautoelectron emission. The temperature of the spot varies, during this process, from ~2500 to 5000°C and the rate of change of the temperature of the spot reaches 10^6 °/sec. At temperatures of the electrode surface above 3000°C, when the oscillation of the temperature of the spot decreases to 100 to 200°, the effect of the dynamics of the spot on the erosion of the electrode decreases. The oscillation of the temperature and dimensions of the spot is explained by the fact that the increase of the arc current leads the increase of the thermoelectron emission in the spot. This creates a high current density on the metal surface (10 to 10^6 A/cm^2) and leads to the appearance of a source of "internal" energy and an increase of the electrode breakdown. (tr-auth)

3926 METALLURGY OF ALLOY 800. Stone, P. G.; Orr, J.; Guest, J. C. J. Brit. Nucl. Energy Soc.; 14: No. 1, 25-34 (Jan 1975).

Following a review of published information on the metallurgy of the iron–chromium–nickel system, attention is directed to the metallurgical significance of relatively minor compositional variations introduced in Alloy 800 to meet the stress corrosion requirements of the nuclear power industry. These include the effect of carbon, nitrogen, titanium, and aluminium restrictions for light-water reactor, high-temperature reactor, and fast reactor applications. Solubility effects are considered in relation to heat-treatment procedures, metallurgical phenomena, and associated properties. The ageing behavior is discussed and related to fabrication and service performance, particularly stress rupture behavior. The effect on these aspects of straining at ambient and elevated temperature is indicated. (auth)

Corrosion and Erosion

Refer also to abstracts 3644, 5345, and 5647.

3927 (AD/A-002668) KINETICS AND MECHANISM IN THE OXIDATION OF METAL VAPORS. Final Technical Report, February 1973–July 1974. Zavitsanos, P.; Golden, J. A. (General Electric Co., Philadelphia, Pa. (USA)). Oct 1974. Contract F30602-73-C-0121. 20p. (RADC-TR-74-292). NTIS $3.25.

In an effort to understand the kinetics and mechanisms of gas-phase metal oxidation reactions, experiments were continued in an apparatus which uses rf heating and laser radiation for the production of the metal vapor and time-of-flight mass spectrometry for product identification and quantitative measurements of reactants and products. Measurements were continued on the oxidation of thorium and uranium by molecular and atomic oxygen, as well as N_2O and rate constants were measured. (GRA)

3928 (EURFNR-1214) CORROSION AND MECHANICAL LONG-TERM BEHAVIOR OF CLADDING TUBES IN SODIUM AT 700°C. Borgstedt, H.; Dietz, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Jul 1974. Translation of KFK-1932. 71p. Dep. NTIS $5.45.

Work performed under United States–Euratom Fast Reactor Exchange Program.

To gain first experimental results on the relations between the mechanical long term behavior and liquid sodium corrosion, tube specimens of the steels no. 1.4970, 1.4981, and 1.4988 (one batch of each) were exposed in the high temperature sodium loop of the Austrian Nuclear Center at Seibersdorf for 5000 hours in sodium of 700°C and a velocity of 5 m/s (oxygen concentration less than 10 w-ppm). During or after sodium exposure the mechanical long-time behavior was tested with internal pressure creep tests. The selective corrosion effects of the tubes evaluated by means of metallurgical examination techniques (metallography, SEM, etc.) are in fair agreement with earlier findings of tests with other specimen sizes (sheet, bar). The formation of a thin (approximately 5 mu m) ferritic subsurface layer and a 35 mu m thick layer with ferritic grain boundaries was independent on the material composition. A loss of boron-1.4970 and of nitrogen-1.4988 was measured. The observed corrosion rates (less than 5 mu m/a) were small compared to earlier results, and the selective effects of Cr, Ni, and Mn, too. The 1.4988 showed a reduced creep strength by 10 to 15 percent (sigma/sub B/5000h/) compared to specimens tested in vacuo or argon atmosphere. The sodium-exposed specimens of 1.4970 and 1.4981 had an increased creep rate compared to unexposed material, too. The causes of these effects on the creep strength may be explained by effects of thermal aging. Further tests are needed to get information on a statistical basis to come to clear conclusions on the effects of sodium on the mechanical properties of cladding tubes corresponding to well defined specifications. This is also important for the evaluation of kinetic rules for the formation of subsurface layers of ferritic grain boundaries. (auth)

3929 (ORNL-TM-4775) EVALUATION OF T-111 FORCED-CONVECTION LOOP TESTED WITH LITHIUM AT 1370°C. DeVan, J. H.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 141p. (NASA-CR-134745). Dep. NTIS $10.25.

A T-111 alloy (Ta–8 percent W–2 percent Hf) forced-convection loop containing molten lithium was operated 3000 h at a maximum temperature of 1370°C. Flow velocities up to 6.3 m/s were used. The results obtained in this forced-convection loop are very similar to those observed in lower velocity thermal-convection loops of T-111 containing lithium. Weight changes were determined at 93 positions around the loop. The maximum dissolution rate occurred at the maximum wall temperature of the loop and was less than 1.3 mu m/year. Mass transfer of hafnium, nitrogen, and, to a lesser extent, carbon occurred from the hotter to cooler regions. Exposed surfaces in the highest temperature region were found to be depleted in hafnium to a depth of 60 mu m with no detectable change in tungsten content. There was some loss in room-temperature tensile strength for specimens exposed to lithium at 1370°C, attributable to depletion of hafnium and nitrogen and to attendant grain growth. (auth)

3930 (TID/SNA-2082) PRELIMINARY SCREENING STRESS CORROSION EVALUATION OF ARMCO ALLOY 22-13-5. Murchison, M. L. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 17 Mar 1971. 7p. Dep. NTIS $4.00.

Evaluation of stress corrosion susceptibility of ARMCO 22-13-5 stainless steel was required for NERVA nozzle application. Testing of sustained stressed tuning fork specimens stressed to 45 ksi was conducted in boiling (309°F) 42% $MgCl_2$ solution for an accelerated laboratory assessment of its stress-corrosion behavior in chloride environments. Results showed failure times and transgranular fracture of both annealed or simulated NERVA braze cycle material are typical of annealed austenitic stainless steels, Type 347 and Type 316. This behavior is expected of annealed 22-13-5 and is highly favorable for NERVA braze cycled material. Further testing of both parent metal and welded forms is recommended for both accelerated environments and marine atmospheres. (auth)

3931 (TID/SNA-2217) DESIGN OF STRESS CORROSION SPECIMEN FOR DETERMINATION OF K_{Iscc} IN PRESSURIZED GASEOUS HYDROGEN EXPOSED TO IRRADIATION. Monthly Progress Report, November 1971. Reuter, W. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Dec 1971. 15p. Dep. NTIS $4.00.

Progress on an experiment to look for possible synergistic effects on metal alloys exposed simultaneously to a high fast neutron fluence (10^{20}) and to hydrogen at 1000 psi is reported. The progress is mostly related to specimen design, instrumentation, crack growth detection and preliminary testing of control samples. Stress analysis and thermal analysis have been carried out to avoid excessive temperatures during the irradiation. (LTN)

3932 (TID/SNA-2218) DESIGN OF STRESS CORROSION SPECIMEN FOR DETERMINATION OF K_{Iscc} IN PRESSURIZED GASEOUS HYDROGEN EXPOSED TO IRRADIATION. Monthly Progress Report, October 1971. Reuter, W. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Nov 1971. 9p. Dep. NTIS $4.00.

Experiments are planned to expose four metal alloys to a high neutron fluence (10^{20}) and simultaneously to hydrogen at 1000 psi and 150° to 200°F to determine whether there are any synergistic effects, especially with respect to stress corrosion and crack growth. (LTN)

3933 (TID/SNA-2220) DESIGN OF STRESS CORROSION SPECIMEN FOR DETERMINATION OF K_{Iscc} IN PRESSURIZED GASEOUS HYDROGEN EXPOSED TO IRRADIATION. Monthly Progress Report, August and September 1971. Reuter, W. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 5 Oct 1971. 16p. Dep. NTIS $4.00.

Progress on an experiment to look for possible synergistic effects on metals exposed simultaneously to a high fast neutron flux (10^{20}) and to hydrogen at 1000 psi is reported. Some instrumentation problems have been encountered: the resistance of strain gages expected to evaluate crack growth during the test in the reactor have shown a large drift due to the radiation. Other types of strain gage are being investigated. Metallurgical preparation for specimens has been defined and stress analysis is continuing. (LTN)

3934 (TID/SNA-2221) DESIGN OF STRESS CORROSION SPECIMEN FOR DETERMINATION OF K_{Iscc} IN PRESSURIZED GASEOUS HYDROGEN EXPOSED TO IRRADIATION. Monthly Progress Report, June 1971. Reuter, W. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 8 Jul 1971. 12p. Dep. NTIS $4.00.

Progress is reported on an experiment to look for possible synergistic effects on metal alloys exposed simultaneously to a high neutron fluence (10^{20}) and to hydrogen at 1500 psi. Methods of detecting slow crack growth are being investigated. The first reactor test is planned to test the instrumentation concepts and specimen design; hydrogen will not be used in this test. (LTN)

3935 (TID/SNA-2222) DESIGN OF STRESS CORROSION SPECIMEN FOR DETERMINATION OF K_{Iscc} IN PRESSURIZED GASEOUS HYDROGEN EXPOSED TO IRRADIATION. Monthly Progress Report, May 1971. Reuter, W. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 7 Jun 1971. 8p. Dep. NTIS $4.00.

Progress on an experiment to look for possible synergistic effects on metal alloys exposed simultaneously to a high fast neutron fluence and to hydrogen at 1000 psi is reported. Progress is related to specimen design, methods of bonding the specimen to the encapsulation device (welding, brazing, or epoxy adhesive) and instrumentation and connecting cables (stress wave analysis, acoustic emission). (LTN)

3936 EFFECT OF LOW-TEMPERATURE AGING ON CORROSION RESISTANCE OF 18Cr–2Mo TITANIUM-STABILIZED FERRITIC STAINLESS STEEL. Lizlovs, E. A.; Bond, A. P. (Climax Molybdenum Co., Ann Arbor, MI). J. Electrochem. Soc.; 122: No. 5, 589–593(May 1975).

Corrosion tests were conducted on 18Cr–2Mo titanium-stabilized ferritic stainless steel aged at 620°C for various time periods. Sensitivity to intergranular corrosion was detected in the Streicher test but not in the Strauss or Warren tests. The corrosion resis-

tance in 45 percent boiling formic acid and in dilute chloride solution (600 ppM Cl^- + 20 ppM Cu^{++}, 90°C) was unaffected by aging at 620°C. Pitting potentials in molar NaCl at 25°C were also unaffected by the 620°C heat-treatment. Corrosion tests were also performed with the same 18Cr–2MoTi stainless steel aged at 475°C for 240, 2400, and 4800 h (18Cr–2MoTi steel is embrittled after 240 h at 475°C). The 475°C heat-treatment affected corrosion resistance to boiling formic acid. Corrosion resistance started to deteriorate after 2400 h aging and was seriously impaired after 4800 h aging. Pitting potentials were rendered less noble by the 475°C treatment. The 475°C embrittlement did not result in sensitization to intergranular corrosion in any environment as contrasted to the 620°C treatment which did sensitize the steel to intergranular corrosion in the Streicher test. (auth)

3937 EROSION OF TUNGSTEN ALLOYS IN A LOW-VOLTAGE, SPARK DISCHARGE. Savitskii, E. M.; Skotnikov, S. A.; Povarova, K. B.; Makarov, P. V. Fiz. Khim. Obrab. Mater.; No. 1, 16-21(1975). (In Russian).

Studies were made of the erosion of cast tungsten and a number of its alloys in a single discharge of a powerful, low-voltage spark. Tungsten erosion occurs by metal evaporation from the surface in the discharge zone. Alloying of tungsten with 2 to 5 wt % of metal (Nb, Ta, Mo, Re) intensifies evaporation and the inhomogeneity associated with the character of the distribution of alloying elements along the grain and distortion of the crystal lattice of tungsten. Cracks are formed in many cases on cooling in the discharge zone. Erosion of a series of oxide inclusions takes place under the effect of the discharge; erosion of carbides is not observed. Mono- or polycrystalline tungsten highly purified from inclusion and replacement impurities had the greatest resistance to erosion. (SJR)

3938 KINETICS OF INITIAL OXIDE GROWTH ON Fe–Cr ALLOYS AND THE ROLE OF VACANCIES IN FILM BREAKDOWN. Cox, M. G. C.; McEnaney, B.; Scott, V. D. (Univ. of Bath, Eng.). Phil. Mag.; 31: No. 2, 331-338(Feb 1975).

The transition from slow oxidation of Fe–Cr alloys covered with a protective film of chromium-rich α-M_2O_3 to the faster rate characteristic of the formation of thicker duplex oxide scales (M_3O_4) is described. The morphology of localized film breakdown together with discrete, sequential changes in the oxidation rate constant indicate that film failure is associated with the condensation into voids at the metal–oxide interface of vacancies injected into the metal during the oxidation process; the vacancy fraction prior to condensation is estimated to be $\sim 10^{-2}$. Since metal freshly exposed to gaseous oxidant is depleted in chromium as a result of the formation of the initial oxide film, growth of crystals of spinel oxide is now favored. The number of spinel nuclei remains essentially constant after the initial period but they increase in size relatively quickly to cover the entire surface with a duplex scale. A model for the process is developed which accords well with kinetic data. (auth)

3939 STUDIES OF A MECHANISM FOR MATERIAL WASTAGE BY SODIUM-WATER REACTION JETS. Tregonning, K.; Mackay, A.; Buxton, K. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). J. Brit. Nucl. Energy Soc.; 14: No. 1, 77-82(Jan 1975).

A mechanism for material wastage caused by small water leaks in sodium-heated steam generators is proposed, which involves the entrainment of corrosive reaction-product droplets from the envelope of a steam–hydrogen jet, and their subsequent impingement on an adjacent tube. The validity of the proposition is examined and substantiated by experiments in which a high-pressure nitrogen jet is submerged in molten sodium hydroxide at temperatures up to 700°C and directed at stainless-steel target plates. Results of static corrosion experiments and lead erosion experiments are used to provide further information on the mechanisms. (auth)

3940 DESIGN ENGINEERING IMPLICATIONS AND ASSESSMENT. Brown, J. (Central Electricity Generating Board, Barnwood, Eng.). J. Brit. Nucl. Energy Soc.; 14: No. 1, 21-24 (Jan 1975).

Designers have had to learn to take account of steel corrosion which may turn out to be much greater than that indicated by extrapolation from short-term tests. Wherever oxidation can occur, steps must be taken to avoid interface corrosion and bolt failure, particularly in mild steel. Boiler material of 9% chromium is now known to suffer from breakaway corrosion and, although the economic life of the station appears unlikely to be reduced because of boiler failure, some output loss over life will occur. Oxide of the cladding material of the fuel pins is expected to spall off, especially as a result of large temperature changes. In order to reduce radiation hazards from these active particles which may settle in low-velocity areas of the circuit, central inertial collectors are being fitted to the outlets of about half the fuel channels, but boiler oxidation products will necessitate a much increased collector capacity. Active oxide particles from the fuel pins may contaminate the irradiated fuel handling route, including the cooling ponds, and so cause maintenance difficulties. (auth)

3941 EFFECT OF OXYGEN AND TIN ON THE MECHANICAL AND CORROSION PROPERTIES OF ZIRCONIUM CONTAINING NIOBIUM 1.0 AND 2.5 ATOMIC PER CENT. Tararaeva, E. M.; Murav'eva, L. S.; Ivanov, O. S. pp 158-162 of Stroenie i Svoistva Splavov dlya Atom. Energ. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Corrosion tests on Zr–Nb (1.0 or 2.5 at.-%) in water at 300°C and water vapor at 400°C and 100 atm. over 9000 h periods were made to determine the effect of alloying additions of Sn (1 to 2 at.-%) and O. Maximum increase in the initial strength, with no significant loss in ductility, was provided by alloying both Zr–Nb alloys with Sn + O; after the corrosion tests there were increases in strength and in relative elongation. The alloy providing the most favorable conditions of strength and corrosion resistance was that containing 1.0% Nb + 1.0% O. (Metals Abstr.)

3942 THE INITIAL OXIDATION OF MOLYBDENUM. I. LEED and RHEED Observations on (110) Molybdenum. Kennett, H. M.; Lee, A. E. (Cambridge Univ. (UK). Cavendish Lab.). Surface Sci.; 48: No. 2, 591-605(1975).

The interaction of oxygen with a clean (110) molybdenum surface was studied by the LEED and RHEED techniques. At room temperature two simple chemisorbed structures are found, at higher exposures a multiple order pattern is seen. At temperatures above 750 K a complex LEED pattern is observed. Initially a corresponding RHEED pattern is seen which has a different structure. Epitaxial oxide nucleation may be followed by RHEED but the initial process is not seen by LEED. More extensive epitaxial films are needed before oxide reflections appear in the LEED pattern. The formation of an epitaxial oxide film is accompanied by the growth of {100} molybdenum facets. These may be seen after the film has been carefully evaporated away. The nuclei of oxide which form are shown by both RHEED and transmission microscopy of replicas to be characteristically shaped. (auth)

3943 THE INITIAL OXIDATION OF MOLYBDENUM. II. RHEED Observations on (100) and (111) Surfaces. Kennett, H. M.; Lee, A. E. (Cambridge Univ. (UK). Cavendish Lab.). Surface Sci.; 48: No. 2, 606-616(1975).

The RHEED technique was used to follow the interaction of (100) and (111) surfaces of molybdenum with oxygen. The (100) surface develops {211} and {110} facets when heated in oxygen above about 1000 K. The equilibrium form of the (100) surface was determined as a function of temperature over a wide range of oxygen pressures. The activation energy of removal of the facets was determined as 0.39 MJ $mole^{-1}$. At temperatures below 1000 K epitaxial oxide nuclei form on the smooth (100) surface before faceting starts. However, nuclei may be grown on a surface which has previously been faceted. In this case the epitaxy is unaltered. On the (111) surface faceting to {211} surfaces always precedes the nucleation of epitaxial oxide. On this face oxide nuclei may be grown by heating from room temperature a surface previously saturated with oxygen. (auth)

3944 THE INITIAL OXIDATION OF MOLYBDENUM. III. Oxide Nucleation Rates on (100) and (110) Molybdenum Surfaces. Kennett, H. M.; Lee, A. E. (Cambridge Univ. (UK). Cavendish Lab.). Surface Sci.; 48: No. 2, 617-623(1975).

The induction periods for the nucleation of epitaxial oxide on (100) and (110) surfaces of molybdenum were determined. The role of impurities was investigated by AES. It is found that only gross amounts of impurity are likely to be significant. Under isobaric conditions the activation energy associated with nucleation is 0.11 ± 0.2 MJ $mole^{-1}$ on both faces between 700 and 1050 K. At 850 K the induction rate is proportional to the pressure. Under isoposal conditions on the (110) surface an activation energy of 0.22 ± 0.03 MJ $mole^{-1}$ is found. (auth)

3945 THE INITIAL OXIDATION OF MOLYBDENUM. IV. Epitaxial Growth of Oxide on Molybdenum. Kennett, H. M.; Lee, A. E. (Cambridge Univ. (US). Cavendish Lab.). Surface Sci.; 48: No. 2, 624-632(1975).

The oxide which grows in low oxygen pressure and at temperatures between 700 and 1000 K on molybdenum is shown to be MoO_2. The epitaxial relationships between the oxide and the metal (100), (110) and (111) surfaces are given. The epitaxial relationships of oxide on the molybdenum (100) and (110) surfaces are geometrically equivalent. The oxide grows on the (111) molybdenum surface with no major oxide plane parallel to the substrate. It is suggested that the epitaxy of MoO_2 on the (111) surface is

a consequence of growth on {211} molybdenum facets. The atomic positions in the pairs of interfacial planes found are given. There is little agreement between the positions of ions in the oxide and substrate lattice sites. Only in the postulated cause of MoO_2 on {211} Mo facets is a small misfit found. (auth)

3946 THE INITIAL OXIDATION OF MOLYBDENUM. V. A Model for the Nucleation of Epitaxial Oxide and Its Application to Molybdenum. Kennett, H. M.; Lee, A. E. (Cambridge Univ. (UK). Cavendish Lab.). Surface Sci.; 48: No. 2, 633-648(1975).

A new model for the phenomenon of epitaxial oxide nucleation is presented. The growth characteristics of the oxide suggest that the prenucleation growth is governed by the oxygen adsorption rate at the oxide/gas boundary. As the oxide grows the calculated rate of dissolution of cations at the oxide/metal interface falls until this becomes rate determining. At this point low work function facet sided pits are etched in the substrate with corresponding bulges in the outer oxide film. These bulges are identified as epitaxial nuclei. Based on this model several parameters relating to oxide growth may be calculated. The agreement between theory and experiment is very good. In particular a lower and upper temperature limit for nucleation are found and the pressure dependence is shown to be quite complicated. The basis of the model can be extended to the chemisorption regime. It is shown that above a surface potential of about 1 V cations migrate rapidly through the oxygen layer. The onset of this rapid migration is identified with molecular oxide production and the start of faceting. (auth)

3947 DECARBURIZATION OF FERRITIC STEELS IN FLOWING SODIUM BETWEEN 475 AND 550°C. Sannier, J.; Paidassi, J.; Dixmier, J. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie); Leclercq, D.; Konovaltschikoff, O. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Chimie Appliquee). J. Nucl. Mater.; 55: No. 2, 169-176(Feb 1975). (In French).

The behavior in flowing sodium of some ferritic steels with different chromium contents (2.25-9%) was investigated at temperatures from 475 to 550°C. No decarburization was observed, even after 7000 h at 550°C, either for steels with 5% chromium and over, or for the 2.25% chromium stabilized steels. For the 2.25% chromium unstabilized steel, the decarburization occurs only at temperatures above 475°C. The magnitude of this phenomenon considerably increases from 500 to 550°C. The carbon concentration-distance profile shows that this process is carbon-diffusion controlled. The decarburization model of this ferritic steel agrees better with the solid-solution diffusion theory than with the moving-boundary diffusion model. (auth)

3948 MECHANISM OF Fe AND Cr TRANSPORT BY LIQUID SODIUM IN NON-ISOTHERMAL LOOP SYSTEMS. Kolster, B. H. (Metaalinstituut TNO, Apeldoorn, The Netherlands). J. Nucl. Mater.; 55: No. 2, 155-168(Feb 1975).

During closed loop experiments with flowing sodium under non-isothermal conditions a large number of specimens was exposed at various temperatures in the heated and cooled zones. In particular, the influence of the oxygen concentration in the sodium, between 1 and 25 ppM, on the metallographic appearance of the specimens was studied. To that end a comprehensive metallographic examination of the exposed specimens was carried out, using optical and electron microscopy and X-ray techniques. The most important metallographic results are summarized, from which a tentative explanation of the influence of oxygen on the transport mechanism of Fe and Cr is deduced. (auth)

3949 LOCALIZED ELECTRON TRANSPORT IN CORRODING ZIRCONIUM ALLOYS. Ramasubramanian, N. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). J. Nucl. Mater.; 55: No. 2, 134-154(Feb 1975).

Zircaloy-2, in the as-received and heat-treated conditions, and the binaries of Zr with Sn, Fe, Cr and Ni, were oxidized in a fused salt medium at 300 and 400°C. The electrochemical polarization behavior was studied at various oxide film thicknesses. Metal electrodes were evaporated on to the oxide films and the dc conduction of the alloy-oxide-metal diodes was investigated. Analysis of the data shows that the presence of the Zr–Fe intermetallic phase is associated with an enhanced localised electron transport which leads to low negative corrosion potentials and fast oxidation rates; the high temperature oxidation behavior of zirconium alloys falls into two distinct groups depending on the presence or absence of this intermetallic phase. In proposing a model for the oxidation of zirconium alloys, information regarding the processes controlling ion and electron transport is essential. Because of the possibility of electron transport occurring through the bulk oxide and at localized second-phase precipitates by different mechanisms, it is unlikely that there is a simple relation between the electron current and potential drop across the oxide. (auth)

Preparation and Fabrication

Refer also to abstracts 3882 and 5488.

3950 (AED-CONF-74-538-013) METALLURGICAL PROCESSES IN BRAZED JOINTS WITH EXAMPLES OF HIGH-TEMPERATURE STAINLESS STEEL BRAZED JOINTS. Presented by a Film. Lison, R.; Gerken, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Zentralabteilung Allgemeine Technologie). 1974. 8p. (In German). INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

15 figs.; 1 tab.; 5 refs. With abstract. Available from ZAED.

Interaction of the molten filler metal and the base alloy, changes due to diffusion processes after hardening of the filler metal for different compositions, formation of new phases, and investigations of diffusion processes in stainless steel brazed joints are discussed. (GE)

3951 (AED-CONF-74-538-014) MECHANICAL PROPERTIES OF NARROW-GAP WELDS IN STEEL 22NiMoCr37. Henderson, I. D.; Seifert, K.; Steffens, H. D. (Institut fuer Angewandte Materialforscung, Bremen (F. R. Germany)). 1974. 10p. (In German). INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

19 figs.; 5 tabs.; 9 refs. With abstract. Available from ZAED.

Narrow-Gap welding is used to join 22NiMoCr37 steel weldments with section thicknesses up to 100 mm. The mechanical properties of the welded joints are compared with the base material properties. (auth)

3952 (AED-CONF-74-538-032) SUBMERGED ARC WELDING OF HIGH-TEMPERATURE UNSTABILIZED AUSTENITIC STEEL X6CrNi1811 FOR SODIUM-COOLED REACTORS. Wallner, F. (Vereinigte Oesterreichische Eisen- und Stahlwerke A. G. (VOeEST) - Alpine Montan, Linz). 1974. 8p. (In German). INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

11 figs. With abstract.

Requirements placed on filler metal and weld metal used in submerged arc welding of unstabilized austenitic steel X6CrNi1811 are given. Effects of base metal, filler metal and welding parameters on the amount and distribution of delta ferrite in the weld metal are discussed. Hot-cracking resistance, weld metal characteristics after prolonged annealing, and examples of applications are also discussed. (GE)

3953 (CONF-740570-P1, pp 3.1-3.9) DIRECT OBSERVATION OF THE EVAPORATION OF DOPING AND TRACE ELEMENTS DURING TUNGSTEN SINTERING. Scheiner, L. (Osram GmbH, Augsburg, Ger.). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The application of the atomic absorption method to the determination of doping elements and trace impurities in W during the sintering process is evaluated. The principle of the method is described and results discussed. The atomic absorption characteristics for K, Al, Si, Fe, Co, Ni, Mg, Ca, Na, Sn, As, and Mo are tabulated for use in the analysis of W during sintering. (JSR)

3954 (CONF-740570-P1, pp 4.1-4.5) VAPOR PHASE PLATING OF TUNGSTEN BY AN OXIDATION-REDUCTION CYCLE. Davis, G. L.; Charlton, M. G. (Mullard, Mitcham, Surrey, Eng.). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

In the oxidation-reduction cycle, heated W metal is exposed to humified H_2 at 1 atm and is converted to volatile hydroxy compounds which are then reduced to give W metal. The reaction and kinetics are discussed, and experiments were conducted. The deposits were columnar and of high purity; they are more resistant to roughening by electron bombardment, thus reducing the fall in x-ray output with time. (DLC)

3955 (CONF-740570-P1, pp 6.1-6.9) MODEL FOR THE RECRYSTALLIZATION BEHAVIOR OF DOPED TUNGSTEN WIRE BASED UPON THE PARAMETERS OF THE BUBBLE DISPERSION. Thompson-Russell, K. C. (Philips Gloeilampenfabrieken, Maarheeze, Netherlands). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

A step-wise growth mechanism is suggested for the recrystallization reaction which results in the development of elongated recrystallized grains having a [531]-type wire texture. The two requirements for this reaction are (1) small second-phase bubbles or particles, dispersed in rows and (2) a very large stored energy due to the preceding deformation. This phenomenon was also observed in doped molybdenum and W–1.5 wt.% ThO_2. (auth)

3956 (CONF-740570-P1, pp 7.1-7.21) EFFECT OF DOPING ADDITIVES ON THE FORMATION OF BUBBLES IN TUNGSTEN. Yamazaki, S.; Koseki, I.; Ogura, S.; Akiyama, R. (Tokyo Shibaura Electric Co., Ltd.). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The effect of dopants on the reduction of tungsten oxides to metal powders and on the inclusion of Al, Si, and K in metal particles was investigated. Another investigation was carried on to examine the relation between dopant concentration in tungsten metal particles and the density of rows of bubbles and the shape of recrystallized grains in annealed wires. K_2O and SiO_2, doped at the same time, cause $\alpha - W$ and $\beta - W$ to be formed relatively early in the reduction process. Therefore, at a further stage, it accelerates the formation of growing $\alpha - W$ particle and, consequently, causes Si and K to be included in tungsten metal particles. With additional Al_2O_3 to K_2O and SiO_2 as dopant, $\beta - W$ formed at an early stage of the reduction process and Al and especially K concentration in tungsten metal powders increase proportionally. During sintering, Al and Si volatilize easily and remain in less than 0.003 wt.% in the sintering ingots. However, only K remains significantly, about 55 to 70% of its contents in tungsten metal powders. Conclusively, K concentration in the wires increases with them in the tungsten metal powders. With the increase of K concentration in wires, the density of rows of bubbles increases almost monotonously and the elongated recrystallized grains become easily formed. Additional Al_2O_3 to K_2O and SiO_2 as dopant effectively increases K included in tungsten metal particles and, therefore, results in increasing the contents of K rather than Al in wires. Consequently, this factor contributes to the formation of considerable rows of bubbles and of large elongated recrystallized grains. (11 figures) (auth)

3957 (CONF-740570-P1, pp 11.1-11.20) PREPARATION OF HIGH PURITY MOLYBDENUM FROM MOLYBDIC SOLUTIONS TREATED BY ION EXCHANGE. Lorang, G.; Langeron, J. P.; Vu Quang Kinh. (CNRS, Vitry-sur-Seine, France). 1974. (In French).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

Ion exchange chromatography was tested for removal of impurities from molydic solutions before its reduction to the metallic state. Principles of this technique are outlined. Partition of Mo, W, and Ta between the Dowex resins and different media was determined. A scheme for the purification of molybdic solutions was formulated on the basis of the data from the partition study. Metallic Mo obtained after ion exchange purification showed that this is a particularly efficient method for removing the major impurities; only Na remained in concentrations of about 30 ppM. Measurements of the electrical resistivity at the temperature of liquid He confirmed the activation analyses. (JSR)

3958 (CONF-740570-P1, pp 12.1-12.18) PROCESSES IN THE SINTERING OF COMMERCIAL MOLYBDENUM ALLOYS AND EFFECT ON THE PROPERTIES OF THE FINISHED PRODUCT. Eck, R. (Metallwerk Plansee AG. and Co., Reutte, Austria). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

Problems encountered in the sintering of the Mo alloy TZM are outlined. Effects of various C admixtures on the C–O balance under various sintering conditions and of various Ti, Zr, and C admixtures on the recrystallization and grain growth behavior and on the stability of this alloy were discussed. The introduction of Si and O under various sintering conditions was reported for Mo doped with K and Si. The varying composition of sintered rods with respect to K and Si and the pore formation and sintered rods and in the deformed state was evaluated from electron optical studies and microprobe measurements. The recrystallization behavior of K–Si-doped Mo wires, TZM wires, Mo alloy wires containing Co, and Mo wires was studied under tensile stress. (tr-auth)

3959 (CONF-740570-P1, pp 13.1-13.17) DEVELOPMENT OF WEAR-RESISTANT THERMAL SURFACE LAYERS ON A MOLYBDENUM BASE. Beyer, H. (Friedrich Goetze AG, Burscheid, Ger.). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The development of wear-resistant layers on Mo by flame sputtering with an oxygen-acetylene torch and by plasma sputtering for use in internal combustion engines is discussed. Effects of the addition of Si, Cr, Ti, and C are analyzed. Use of cermets is also considered. The resistance of these coatings under various thermal regimes in motors is compared. (JSR)

3960 (CONF-740570-P1, pp 15.1-15.18) THERMO- AND ELECTROTRANSPORT OF OXYGEN AND NITROGEN IN VANADIUM, NIOBIUM, AND TANTALUM. Kirchheim, R.; Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

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Thermo- and electrotransport experiments of oxygen and nitrogen in vanadium, niobium, and tantalum are described. It was found that the dissolved gas atoms migrate to the cathode in an electric field, whereas in a temperature gradient they migrate to the hotter regions of the sample, as far as thermotransport could be observed in the different systems. Results are expressed by the usual parameters Q^* (heat of transport) and Z^* (effective charge), whose dependence upon temperature and concentration was determined in the Ta–O system. An interpretation of the transport phenomena is given using the electron drag model. Changes in interstitial concentration were estimated, which should be expected in the metals after heating them with ac or dc current. First-order approximations are derived for the changing content of nitrogen and oxygen in tantalum, when they are heated by internal resistance. (auth)

3961 (CONF-740570-P1, pp D1.1-D1.10) CHEMICAL VAPOR DEPOSITION OF TUNGSTEN, TANTALUM, AND MOLYBDENUM BY THE CHLORIDE REDUCTION PROCESS. Shroff, A. M. (Thomson-CSF, Paris). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

The method described consists in producing the chloride prior to its reduction, in a reaction chamber adjacent to the reduction chamber. Reduction by H_2 is effected at 900 to 1500°C. Equipment used and results are described. Results show that the "in-situ" chlorination method produces dense, adherent thin layers. (DLC)

3962 (CONF-740570-P1, pp D2.1-D2.16) ELECTRON MICROSCOPIC STUDIES ON DOPED TUNGSTEN. Ruehle, M.; Keller, I. (Max-Planck-Institut fuer Metallforschung, Stuttgart). 1974. (In German).

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

Transmission electron microscopic studies on Al, K, and Si-doped W at various production stages showed that immediately after sintering, nonmetallic inclusions are found in the W. The inclusions are very stable and they can be chemically dissolved out of the W. K and Al can be detected in the inclusions. Similar inclusions can be found in an annealed rod of 4.5 mm ϕ. Long cylindrical bubbles about 40 Å thick and several μ long were detected in drawn untempered wires. Very small bubbles form from these cylindrical bubbles after tempering of the wires at 2300°C. The small bubbles in the annealed wires are very effective obstacles to dislocation movement. (tr-auth)

3963 (LFEN-148-a) MECHANISM OF DEGASSING DURING VACUUM MELTING OF STEEL. Carvalhinhs, H.; Baptista, A. A. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). 1972. 7p. (In Portuguese). INIS.

The most important mechanisms that control the removal of oxygen, hydrogen, and nitrogen during vacuum melting of steel are reviewed. In particular the theories of the static boundary layer, of Dankwerts and of Machlin and Kraus, which describe oxygen outgassing, are briefly outlined. (INIS)

3964 (TID/SNA-2051) TESTING PROGRAM AND TEST RESULTS OBTAINED ON THREE HEATS OF ARMCO 22-13-5 ELECTROSLAG REMELT ALLOY. (Wyman-Gordon Co., Worcester, Mass. (USA)). 1 Dec 1971. 28p. Dep. NTIS $4.50.

Details of the testing program and test results obtained on three heats of Armco 22-13-5 electro-slag remelt alloy are reported. The testing program was intended to determine the forgeability of this alloy for the Nerva project. Based on the data generated in this forgeability study, a maximum forging

temperature of 2150°F is suggested for processing this material. Higher forging temperatures, e.g., 2200-2275°F, appear to promote non-uniform grain recrystallization, a tendency towards surface rupturing, and a decrease in tensile ultimate strength. (auth)

3965 PREPARATION OF SINGLE CRYSTALS OF REFRACTORY METALS BY USE OF PLASMA ARC HEATING. Savitskii, E. M.; Burkhanov, G. S.; Raskatov, N. N.; Shnyrev, G. D. pp 132-137 of Plazmennye Protsessy v Metallurgii i Tekhnologii Neorganicheskikh Materialov. Paton, B. E. (ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

A method for the preparation of coarse single crystals of W and Mo by using plasma arc heating was described. The advantages of this method of growing crystals and the processes of their purification and growth are examined. (tr-auth)

3966 PLASMA ARC DROP FUSION FOR THE STUDY OF PHYSICAL-CHEMICAL PROCESSES OF REFINING AND CRYSTALLIZATION OF MELTS OF REFRACTORY METALS. Kashin, V. I.; Klibanov, E. L.; Semenov, V. G. pp 137-143 of Plazmennye Protsessy v Metallurgii i Tekhnologii Neorganicheskikh Materialov. Paton, B. E. (ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Various aspects of the use of plasma arc drop fusion for the study of the physical-chemical processes of refining and crystallization of refractory metals are examined. Practical material on the study of the interaction of liquid Mo and W of different compositions with N_2, O_2, C, and oxides and procedures for evaporation of impurities from the metals are included. A method for the measurement of the temperature of an alloy in an arc was described. The possibility of using this method for the study of rapidly occurring processes in the crystallization of refractory metals was shown. (tr-auth)

3967 STUDIES ON THE Al_2O_3-Ti-Mo-Au METALLIZATION SYSTEM. Harris, J. M.; Lugujjo, E.; Campisano, S. U.; Nicolet, M. A. (California Inst. of Technology, Pasadena). J. Vac. Sci. Technol.; 12: No. 1, 524-527(1975).

The behavior of Ti-Mo-Au metallization on Al_2O_3 and C was investigated by backscattering spectrometry. Results show that Mo-Au bimetal films typically mix during deposition. Diffusion of Ti in Mo film occurs at 600°C, but is inhibited by the presence of oxygen in the Ti film. Even 1000 A of Mo is not a barrier against interdiffusion of Ti and Au during 20-min anneals at 600°C. The amount of mixing observed also depends on the nature of the substrate which supports the Ti-Mo-Au metallization. (auth)

3968 TREATMENT OF ZIRCONIUM DIOXIDE. Hardy, C. J.; Woodhead, J. L.; Crossley, D. British Patent 1,373,661/B/. 13 Nov 1974. 3p.

A method is described for the recovery of the Zr content of baddeleyite. This mineral is the major source of uncombined ZrO_2 and has an oxide content of 70 to 80%. It is, however, somewhat intractable to conventional techniques for recovery of the Zr content. The pulverized ore can be dissolved in concentrated H_2SO_4, but the pulverization is an expensive operation. The method described comprises treating the material in particulate form (63 to 200μm) with an aqueous mixture of HCl and HF at least 130°C and under pressure. The material does not need to be pulverized. It is preferable to use the acids in a molar ratio HCl: HF of 5:1 to 0.5:1. The pressure of water is believed necessary to avoid unwanted side reactions. It is convenient to operate at the pressure generated by the reacting system. The equipment may suitably be lined with PTFE, and the process may be operated batch-wise or continuously. Some samples of the ore may contain significant amounts of radioactive elements, and methods are described for decontamination of the solutions. (UK)

3969 STUDY OF GAS EVOLUTION FROM MOLYBDENUM ON MELTING. Skrinichenko, T. M.; Klibanov, E. L.; Kashin, V. I. Fiz. Khim. Obrab. Mater.; No. 1, 40-43(1975). (In Russian).

A study was made of the kinetics of desorbing hydrogen and oxygen from molybdenum at the stage of melting a dc arc electrode of reverse polarity. The most important parameters were established determining the course of the refining process during film flow of the metal and drop formation. At current strengths of 100 to 2000 A the degree of purification of molybdenum from hydrogen at the stage of electrode melting was 70 to 95%, and from oxygen the purification was 25 to 60%. From the data an estimate was made of the diffusion coefficients and mass-transfer constants for hydrogen and oxygen in the metal film and drop. (SJR)

3970 X RAY STUDY OF SURFACE COLD HARDENING ON CUTTING SINGLE CRYSTALS. Zasimchuk, E. E.; Shtukaturova, A. S. Fiz. Khim. Obrab. Mater.; No. 1, 88-91(1975). (In Russian).

It is shown that the depth of the cold-worked layer for bcc single crystals (tungsten and molybdenum) after electrospark and mechanical cutting is 0.5 mm. After cutting single crystals of fcc metals (copper and nickel), structural disruptions in different forms are readily apparent at a depth greater than 1 mm. Use was made of a two-crystal, x ray spectrometer to investigate the structure and depth of the cold-worked layer. (SJR)

3971 HIGH RATE RF SPUTTERED NIOBIUM: EFFECTS OF DEPOSITION RATE ON SUPERCONDUCTING PROPERTIES. Rock, F.C.; Smith, C.W. (Department of Physics and Astronomy, University of Maine, Orono, Maine 04473). J. Appl. Phys. 46: No. 5, 2332-2333 (May 1975).

The low-temperature electric properties of niobium films deposited using an rf sputtering system, in which the deposition rate (> 1000 Å/min) and self-bias potential (≈5 kV) are higher than normally encountered, are presented. Comparison is made to existing data on single-crystal Nb films as a function of thickness. It is found that high deposition rates can be the "special technique" needed to produce high-quality Nb films. (auth)

3972 IN ELECTRODEPOSITION FROM TARTRATE ELECTROLYTES. I. Stationary Polarization Measurements. Yasinskaite-Shukene, V. L.; Yuodkazis, K. I.; Vishomirskis, R. M. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 4: No. 83, 49-58(1974).

In alkaline tartrate electrolytes of In sulfate, the potential of In electrode is not determined by equilibrium between this electrode and In complexes in the solution. In given electrolytes, the process of H_2 evolution is prior to the discharge of In complexes. With the beginning of the latter process, the H_2 evolution is hindered. Increase of temperature and pH of electrolytes causes increased speed of the metal electrodeposition. The efficiency of the influence of the mentioned factors depends on the interval of their values. (It has been assumed that in alkaline tartrate solutions In forms the following complexes $[In(OH)_2 tartr_x]^{1-2x}$, where most probably x = 1). (9 fig, 3 tables) (auth)

3973 ELECTROLYTIC MAGNETIC Co-BASE ALLOYS. XIII. Cathodic Processes Occurring During the Electrolysis of $NaVO_3$ Solutions Containing $CoSO_4$. Kharlushene, V. E.; Rachinskas, V. S.; Matulis, Yu. Yu. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 4: No. 83, 61-70(1974). (In Russian).

It has been determined that addition of $NaVO_3(VO_3^-)$ to the H_3BO_3 and $MgSO_4$ solution with or without $CoSO_4$ depolarizes at the low current densities (i_k) the cathodic process the more the concentration of VO_3^- is. The addition of VO_3^- at the higher i_k restricts the cathodic process, causes increased H evolution, and leads to passivation of the cathode surface. It has been shown that before the electrodeposition of Co-V coatings the reduction of VO_3^- till lower valencies, the H_2 evolution and the cathode blocation by basic compounds take place. On the basis of the data, a possible mechanism of the electrodeposition of Co-V electrodeposits is suggested. (auth)

3974 IN ELECTRODEPOSITION FROM TARTRATE ELECTROLYTES. III. State of Cathode Surface. Shukene, V. L.; Garmute, G. P.; Yuodkazis, K. I.; Vishomirskis, R. M. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 5: No. 84, 43-49(1974). (In Russian).

It was experimentally established that on the surface of In deposits, obtained from alkaline solutions, In hydroxide sediments exist, insoluble basic compounds of In were proved not to enter into the deposit. In the measured interval of current density, the purity and porosity of In deposits do not depend on the rate of their electrodeposition. (3 tables, 5 fig) (auth)

3975 IMPROVEMENTS IN OR RELATING TO COBALT-BASED SINTERED PERMANENT MAGNETS. Johnson, R. E.; Fellows, C. J. British Patent 1,373,019/B/. 6 Nov 1974. Filed date 21 Aug 1971. 4p.

A process is described for the production of sintered permanent magnets formed from a Co-based alloy containing substantial quantities of Y, La, rare earth metals, or mischmetal. A powdered Co-R alloy is intimately mixed with a proportion of a second Co-R alloy having a higher R proportion in a protective fluid, such as petroleum ether, and the mixture, including the protective fluid, is loaded into a nonmagnetic die. The mixture in the die is then momentarily subjected to a high strength aligning magnetic field of up to 50 kOe, and then compressed to a coherent compact at a low pressure while maintaining a much lower strength magnetic field of up to 7 kOe to preserve the magnetic alignment. The compact is then subjected to a pressure in the range 2 to 7 kb by means capable of maintaining magnetic alignment without the application of a magnetic field, in order to densify the compact. The double pressed compact is finally sintered in a protective

atmosphere, cooled, and magnetized by momentary application of a high strength field. (UK)

3976 INVESTIGATION OF PROCESS OF ELECTRODEPOSITION OF Co–Mo ALLOYS FROM COMPLEX ELECTROLYTES. III. Influence of Some Additions of Inorganic Salts on the Content of Mo in Deposits in Citric Electrolytes. Byarnotas, A. K.; Bubyalis, Yu. S.; Kaushpedas, Z. P.; Matulis, Yu. Yu. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 3: No. 82, 75-80(1974). (In Russian).

The current efficiency (η_k), amount of Mo and additions in depositions, inclusions and cathodic polarizations were investigated as a function of conditions of electrolysis and composition of electrolyte. Additions of $PdCl_2$, $CuCl_2$, $SnCl_2$, $ZnCl_2$, $NiCl_2$, K_2SeO_4 were found to decrease the amount of Mo in deposits. $PdCl_2$, $CuCl_2$, $ZnCl_2$, $NiCl_2$ decrease η_k too. The amount of Mo in deposits, obtained at $i_k \leq 2$ A/dm^2 depends on the amount of Cu. Results show that the amount of Mo in deposits increases with $MnCl_2$ and $BeCl_2$ additions. (7 fig) (auth)

3977 ELECTROLYTIC MAGNETIC Co-BASE ALLOYS. XIV. Cathodic Processes Occuring During the Electrolysis of Na_2WO_4 Solution Containing the Additions of $NaVO_3$ and $CoSO_4$. Rachinskas, V. S.; Kharlushene, V. E.; Matulis, Yu. Yu. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 4: No. 83, 71-79(1974). (In Russian).

It was determined that an addition of VO_3^- to the WO_4^{2-} solutions with or without $CoSO_4$ depolarizes at the current densities (i_K) the cathodic process the higher the concentration (c) of VO_3^- is. Addition of VO_3^- restricts at higher i_K the cathodic process, causes increased H_2 evolution, and leads to passivation of the cathode surface. It was established that increasing the $CoSO_4$ c and the electrolyte temperature and decreasing pH, the Co–W–V alloys deposition potential (φ_K) is shifted to more positive values. It was shown that before Co–W–V electrodeposition, the reduction of VO_3^- and WO_4^{2-} until the lower valencies, the H_2 evolution and the cathode relocation by the basic compounds take place. On the basis of the data of the investigation, the most probable mechanism of Co–W–N alloy electrodeposition is discussed. (7 fig) (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 3411, 3430, 3885, 3886, 3919, 4996, 5398, 5399, and 5507.

3978 (AD-778097) EVALUATION OF Ti–3Al–2.5V TITANIUM ALLOY HYDRAULIC TUBING. Final Report, June 1972–January 1974. Sanders, L. R. (McDonnell Aircraft Co., St. Louis, Mo. (USA)). Apr 1974. 99p. (AFML-TR-74-55). NTIS $4.00.

The program determined the effect of several Ti–3Al–2.5V hydraulic tubing manufacturing techniques and common tubing defects on rotary flexure fatigue life of the tubing. Test results showed cold-worked and stress-relieved 105 ksi minimum tensile yield strength tubing and annealed 70 ksi minimum tensile yield strength tubing have approximately the same fatigue life. It was shown that belt sanding the tubing outer surface and then pickling both the inside and outside surfaces was the best surface preparation method evaluated. Grit blasting of the tubing inner surface or glass bead peening of the tubing outer surface offered no improvement in fatigue life and in some cases actually reduced fatigue life. The balance of the program was devoted to determining the effect of tubing imperfections. (GRA)

3979 (AD-783324) IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL–CHROMIUM ALLOYS. Final Technical Report, 1 February 1972–30 April 1973. Timbres, D. H.; Norris, L. F. (Sherritt Gordon Mines Ltd., Fort Saskatchewan (Canada)). Mar 1974. 67p. NTIS $3.75.

A dispersion strengthened nickel-base alloy, Ni/16Cr/5Al/2ThO_2, exhibiting excellent high temperature oxidation resistance was subjected to a series of thermomechanical processing studies to optimize its mechanical properties. All properties with the exception of room temperature ductility were above the target specifications for the program. Extensive oxidation tests were conducted on an alternative composition, Ni/9Cr/6Al, with and without a dispersoid (ThO_2) addition. The results indicated that the Ni/9Cr/6Al/2ThO_2 alloy had generally poorer high temperature oxidation characteristics. The mechanical properties, however, were found to be similar to those of the Ni/16Cr/5Al/2ThO_2 alloy. (GRA)

3980 (AD/A-002698) HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY. Campbell, J. E.; Eldridge, E. A.; Thompson, J. K. (Battelle Columbus Labs., Ohio (USA)). Nov 1974. Contract DSA900-75-C-1803. 597p. (MCIC-HB-04). NTIS $35.00.

The major objective of the handbook is to present data that could be used in the development of new concepts in superconducting machinery. Information was collected on the mechanical, thermal, electrical, and magnetic properties of selected structural materials for designers and users of equipment that will be exposed to cryogenic temperatures. The data are presented as "best-value" numbers from compilations of data in the temperature range 0 to 300°K. Materials include Al and Al alloys, Cu alloys, Ni alloys, Nb alloys, Ti alloys, and steels. (GRA)

3981 (AED-CONF-74-516-004) WEAK FLUX PINNING IN LOW-KAPPA TYPE-II SUPERCONDUCTORS. Weber, H. W. (Atominstitut der Oesterreichischen Hochschulen, Vienna). 1974. 6p. INIS.

From international discussion meeting on flux pinning in superconductors; St. Andreasberg, F. R. Germany (23 Sep 1974).

Flux pinning by a small amount of large precipitates was investigated with several niobium single crystals and Nb–Ta alloys with the three different techniques: direct tracings of the flux profiles, neutron diffraction, and neutron depolarization. Flux density gradients for increasing fields as a function of the reduced induction, mosaic spread of the flux line lattice in increasing and decreasing magnetic fields, average tilting and mosaic spread of the flux line lattice, and basic pinning force as a function of the reduced induction are presented. (GE)

3982 (AED-CONF-74-538-007) NORMALIZING OF STRIP CLAD HEAT-AFFECTED ZONES BY TIG-REMELTING. Mulder, J. P. F. (Rotterdamse Droogdok Maatschappij N. V. (Netherlands)). 1974. 3p. INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

7 figs.; 1 tab. With abstract. Available from ZAED.

Methods to normalize the strip clad heat-affected zones by TIG-remelting of the surface part of the clad layer. Results are fine grain microstructures in heat-affected zones, cleaning of the clad, and smooth clad surface. (GE)

3983 (AED-CONF-74-538-010) INFLUENCE OF DIFFERENT ELEMENTS ON THE SUSCEPTIBILITY FOR UNDERCLAD CRACKING AS DETERMINED WITH WELD SIMULATION TESTS. Mulder, J. P. F. (Rotterdamse Droogdok Maatschappij N. V. (Netherlands)). 1974. 3p. INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

1 fig.; 1 tab.; 5 refs. With abstract. Available from ZAED.

Laboratory steel with various additions of alloy and residual elements were prepared. The influence of these elements on the susceptibility for underclad cracking were determined by means of slow tensile testing at stress relieving annealing temperatures with welded simulation tests. (GE)

3984 (AED-CONF-74-538-012) RELAXATION CRACKING IN STEEL ASTM A 508/Cl.2. Lorenz, M. (Sulzer Bros. Ltd., Winterthur (Switzerland)). 1974. 8p. (In German). INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

10 figs.; 2 tabs.; 13 refs. With abstract. Available from ZAED.

Conditions of occurrence, detection, and consequences of underclad cracks in pressure vessels of nuclear power plants are discussed. Investigations were made of the metallurgical causes of cracking. Trace elements are found to be embritteling agents, and the latent sensitivity is given by the content of carbide forming elements. (GE)

3985 (AED-CONF-74-538-036) STRUCTURE AND PROPERTIES OF STAINLESS STRIP CLADDINGS ON PRESSURE VESSEL STEELS. Vartiainen, K.; Hakala, J. (Helsinki Univ. of Technology, Otaniemi (Finland)). 1974. 6p. INIS.

From 2nd international colloquium on welding in nuclear engineering; Duesseldorf, F. R. Germany (23 Oct 1974).

10 figs.; 4 tabs.; 15 refs. With abstract. Published in DVS–32.

The microstructure, cracking susceptibility, mechanical properties and the corrosion resistance of three different welded claddings of pressure vessel steels have been studied, the parameters being the number of cladding layers and the temperature of stress relief annealing. (GE)

3986 (CONF-740570-P1, pp 5.1-5.18) EFFECT OF MICROPOROSITY ON THE RECRYSTALLIZATION AND CREEP BEHAVIOR OF TUNGSTEN WIRES. Horacsek, O.; Bartha, L. (Research Inst. for Technical Physics, Budapest). 1974.

From 8th plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th plansee seminar. Preprints. Vol. I.

Emission microscopy was used to observe how the "dope-porosity" influences the morphology of recrystallized grains and high temperature creep behaviour of powder metallurgical tungsten wires. Regeneration of relatively large grain boundary surfaces is required when migrating grain boundaries cross the "dope-tubes"; therefore, the bubble-rows act for the migration as local energy barriers. As a result of this in KSiAl-doped tungsten wires the mean rate of grain boundary migration is much greater in the axial direction than perpendicular to it, leading to the formation of elongated grains with interlocking grain boundaries. Emission microscopic examination carried out simultaneously with creep deformation showed that the bubbles in doped wires are able to grow during high-temperature creep and can finally cause inter-crystalline rupture. The creep rupture of the pure (undoped) wires is caused also by grain boundary cavities, but the nuclei of the voids are not bubbles but microcracks produced continuously during deformation. An attempt is made to explain the great differences in the creep-ductility of pure and doped tungsten wires. (12 figures) (auth)

3987 (CONF-740570-P1, pp 8.1-8.11) STRUCTURE EFFECTS ON THE MECHANICAL PROPERTIES OF W-10 WT % Re AND W-5 WT % Re ALLOYS. Geldner, E.; Schreiner, H. Siemens AG, Nuremberg). 1974. (In German).

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th Plansee seminar. Preprints. Vol. I.

Heterogeneous inclusions were detected in W–5 wt % Re and W–10 wt % Re alloys by use of a polishing technique. Variations in the Re concentrations and the distribution in the Re-enriched inclusions were determined. Tensile studies were made from room temperature to 500°C. The Re constituent has only an insignificant effect on the stability behavior in this temperature range. Relations between the grain size and the tensile stability were established as a function of the test temperature. A relation was detected between the grain growth and Re distribution after vacuum annealing. (tr-auth)

3988 (CONF-740570-P1, pp 10.1-10.4) STRUCTURE AND DEFORMATION OF THE TUNGSTEN–NICKEL–IRON ALLOYS. Frantsevich, I. N.; Bazhenova, L. G.; Minakova, R. V.; Teodorovich, O. K.; Churakov, M. M. (Inst. of Materials Science, Kiev). 1974.

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

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W–Ni–Fe alloy is in the class of deformable sintered composite alloys. The low-melting matrix phase is a solid solution Ni–Fe–W with mp ≈ 1365 ± 15°C; its composition at 1400 and 1520°C is given. Effects of slow (5°/min) and fast (600°/min) cooling on the structure and mechanical behavior are described. (DLC)

3989 (CONF-740570-P1, pp 14.1-14.36) ELECTRON BEAM WELDING AND STRENGTH TESTS ON MOLYBDENUM AND MOLYBDENUM ALLOYS. Mayer, H. G.; Schaefer, R.; Koeppe, A. (Univ., Stuttgart). 1974. (In German).

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th Plansee seminar. Preprints. Vol. I.

Strength properties at high temperatures were determined for commercially pure sinter Mo, sinter TZM, sinter Mo + B in ppM amounts, sinter Mo + 500 ppM B + 0.8 Hf, sinter Mo + 400 ppM B + 0.5 Hf + 50 ppM C, commercially pure melt Mo, and melt TZM. Results on the strength and deformability are shown graphically and the fracture surface is illustrated. Conditions for the electron beam welding of these materials are determined and the strength of the weld measured. Some examples are given of the use of electron beam welding of Mo and Mo alloys. (47 figures) (JSR)

3990 (CONF-740570-P1, pp D4.1-D4.8) BEHAVIOR IN CREEP OF SINTERED AND CAST MOLYBDENUM. Gregoire, J.; Robert, G. (CEN, Grenoble, France). 1974. (In French).

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th Plansee seminar. Preprints. Vol. I.

The discussion deals with the behavior in creep at 1650°C of different alloys of cast and sintered molybdenum, of modes of fracture, and indicates their suitability for welding. At high temperatures, sintered alloys of molybdenum present by creep a better resistance to deformation than arc-cast molybdenum. This behavior is still further improved by the presence of a dispersion of zirconium. But on the other hand, the ductility of sintered molybdenum is much less than that of cast molybdenum; the blockage of joints leads to the development of intergranular porosities which cause premature fracture. (auth)

3991 (CONF-740570-P2, pp 30.1-30.12) MODIFIED SPINODAL ALLOYS FOR TOOL AND WEAR APPLICATIONS. Rudy, E.; Worcester, S.; Elkington, W. (Oregon Graduate Center, Beaverton). 1974.

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials, Reutte, Austria (27 May 1974).

In 8th Plansee seminar. Preprints. Vol. II.

The paper, centering on alloys based on phase separation phenomena in the Ti–Mo–C–N system, shows that such reaction phenomena can be used with advantage for particular applications. Among the most attractive features of spinodal reactions are the stability of the aggregate structure towards grain growth, the prospect to preselect the nature of the phases so that impurity levels do not critically affect fabricability and properties, and the possibility to obtain property combinations specific to the microstructure formed in spinodal reactions. The finding that the occurrence of critical phases can be controlled by the stability of the boundary phases makes the concept of spinodal alloys more accessible and versatile for practical alloy design problems. (9 figures) (auth)

3992 (CONF-740570-P2, pp D12.1-D12.6) COMPOSITE MATERIALS OBTAINED BY DIRECTIONAL TRANSFORMATION OF POLYVARIANT SYSTEMS. Wolff, L. R. (Univ. of Technology, Eindhoven, Netherlands). 1974.

From 8th Plansee seminar: heat-resisting and wear-resisting sintered materials; Reutte, Austria (27 May 1974).

In 8th Plansee seminar. Preprints. Vol. II.

In directional transformation of eutectoids as well as in directional solidification of eutectics, invariant binary systems can be rendered polyvariant by adding new components while retaining the morphological characteristics of an eutectoid or eutectic respectively. In this way polyvariancy may be an useful tool in adapting these special composites to potential applications. Cu–Al–Ni–In alloys were studied. (auth)

3993 (IC-74-83) STUDY OF DISLOCATION IMPURITY INTERACTIONS IN NIOBIUM BY INTERNAL FRICTION MEASUREMENTS. Hari Babu, V.; Verdini, L. (International Centre for Theoretical Physics, Trieste (Italy)). Aug 1974. 17p. INIS.

The effects of the impurity-dislocation interactions on the low temperature internal friction peaks have been investigated in cold-worked polycrystalline niobium samples. The α-peak has been shown to occur as a result of the hydrogen-dislocation interaction and the δ-peak seems to correspond to a Bordoni type relaxation. The decrease in the height of the α-peak and its annealing temperature is due to the pinning of dislocations by impurities such as oxygen, nitrogen, and carbon. The interaction of these impurities with the dislocations is elastic in nature and is shown to arise as a result of the size effects as compared with the interaction between hydrogen and dislocations which is due to electrostatic effects. The enhancement of the peak height and peak temperature after hydrogen charging is explained on the basis of dragging of hydrogen quanta by the moving dislocations and consequent phase lag between them. Activation energy "H" obtained from the relation between peak height and peak temperature is assumed to be the sum of the activation energy "W" for dislocation motion and the impurity-dislocation binding energy H_b. The decrease in activation energy "H" following hydrogen charging is attributed to the lowering of energy barrier to the dislocation motion, as a result of proton-dislocation interaction. The inability of hydrogen to pin dislocations at α-peak temperatures is explained as due to the high mobility of hydrogen. (INIS)

3994 (IS-T-659) SUPERCONDUCTIVITY AND THE KONDO EFFECT IN QUENCH-CONDENSED FILMS CONTAINING CERIUM. Delfs, R. J. (Ames Lab., Iowa (USA)). Feb 1975. Contract W-7405-eng-82. 124p. Dep. NTIS $9.25.

Thesis.

The superconducting transition temperature, T/sub c/, and the Kondo resistance anomaly were studied in flash-evaporated quench-condensed thin films of Pb(Ce) and In(Ce). In both alloys, cerium caused a uniform depression of T/sub c/, with a slope of 1^0K/at. percent Ce. Measurements after low-temperature annealing and measurements on samples of different residual resistivities, rho_0, showed T/sub c/ to be relatively insensitive to structural disorder. Approximately half of the samples showed a Kondo effect with a resistivity rise proportional to log T at low temperatures. For the In(Ce) system the rise in resistivity over one temperature decade, DELTA rho, equalled .03 mu OMEGA cm/at. percent Ce relatively independent of structural disorder. For the Pb(Ce) system, however, DELTA rho equals 3 mu OMEGA cm/at. percent Ce for disordered films having rho_0 equals 400 mu OMEGA cm, but DELTA rho equals .015 mu OMEGA cm/at. percent Ce for films having rho_0 equals 100 mu OMEGA cm. Similar decreases of DELTA rho with rho_0 were also observed

after low temperature annealing of the films. Calculations of the superconducting state scattering time tau/sub s/ and the normal state Kondo scattering time tau/sub m/ showed that for In(Ce), tau/sub m/ and tau/sub s/ were both approximately equal to 5 x 10^{-12} seconds. For the Pb(Ce) system, however, tau/sub s/ was approximately 8 x 10^{-12} seconds, whereas tau/sub m/ ranged from 4 x 10^{-14} to 8 x 10^{-12} seconds. The result that tau/sub s/ much greater than tau/sub m/ for a sizable fraction of the Pb(Ce) films may signify that the onset of superconductivity greatly depresses the scattering associated with the Kondo effect. (24 figures) (auth)

3995 (LBL-3430) MULTIPLET SPLITTING OF X-RAY PHOTOEMISSION SPECTRA CORE LEVELS IN MAGNETIC METALS. Kowalczyk, S. P.; McFeely, F. R.; Ley, L.; Shirley, D. A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 3p. (CONF-741202-18). Dep. NTIS $4.00.

From 20th annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

The results of high resolution x-ray photoemission studies of the multiplet splitting of the 3s core levels in the 3d transition metals and the 4s, 5s, and 4d core-levels in the lanthanide metals are reported. (auth)

3996 (NRL-7865) STANDARD METHOD OF TEST FOR PLANE-STRAIN STRESS-CORROSION-CRACKING RESISTANCE OF METALLIC MATERIALS. Judy, R. W. Jr.; Goode, R. J. (Naval Research Lab., Washington, D. C. (USA)). 17 Mar 1975. 10p.

The long-term integrity of marine structures depends heavily on the inherent resistance of the structural material to the initiation and propagation of cracks in the seawater environment. In military structures, applied loads are very complex and the design models and laboratory verification experiments are correspondingly complex; however the utility of materials for many applications is decided by the simple characterization of the stress-corrosion-cracking sensitivity in terms of the linear-elastic threshold stress intensity K/sub Iscc/. Because this parameter is important in selecting materials and designing marine structures, it is necessary to formulate a standard method of test to insure uniformity of test results. The report is concerned with the cantilever method for determining K/sub Iscc/ for metallic materials. (auth)

3997 (RD/B/N-2678) MICROSTRUCTURAL CHANGES IN ADJUSTED URANIUM DURING THERMAL CYCLING. Lobb, R. C. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Oct 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

The changes in microstructure of adjusted uranium during thermal cycling between 400 and 600°C are examined using hardness measurements and optical and high voltage electron microscopy. It is found that the changes in microstructure resulting from thermal cycling are similar to those occurring during conventional hot working operations in many materials. Attention is also drawn to the fact that the microstructures produced by cycling have some similarities to those induced by irradiation. The implications of this are discussed. (auth)

3998 (RD/B/N-3129) STRESS-RUPTURE TESTING OF ZIRCALOY TUBE AT 800°C. Clay, B. D.; Redding, G. B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Nov 1974. 20p. Dep. NTIS (US Sales Only) $4.00.

Preliminary results are given of an extensive program of stress-rupture tests designed to obtain basic materials data for Zircaloy-2 over the temperature range 700 to 1100°C for inclusion in analytical models of cladding deformation and rupture under transient temperature conditions in water reactors. A high resolution photographic technique is described which allows direct measurement of strain throughout a rupture test, giving the minimum creep rate as a function of hoop stress. The results of initial tests at 800°C in argon on Zircaloy tubes in both the fully annealed and stress relieved conditions are given and a value of the stress exponent, n, determined. An analysis of the stress-rupture tests, based on the Monkman-Grant relation, shows that the product of rupture life and minimum creep rate is a constant which is a function of the stress exponent. The analysis is extended to include the significant contribution of primary creep strain and the present results are used to investigate the validity of the relation. Results are also given of a series of uniaxial, constant load tests on specimens, taken from the tube material, which corroborate both the biaxial creep data and the rupture life analysis. (auth)

3999 (RDT-M-2-6T(3-75)) MARTENSITIC STAINLESS STEEL (TYPE 403) FORGINGS (ASME SA-182 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Mar 1975. 5p. RSO.

A standard prescribing requirements for martensitic stainless steel (Type 403) forgings (ASME SA-182 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 2-6T, dated November 1973. (JRD)

4000 (RDT-M-3-7T(4-75)) AUSTENITIC STAINLESS STEEL WELDED PIPE, LARGE DIAMETER (ASME SA-358 WITH ADDITIONAL REQUIREMENTS). (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Apr 1975. 6p. RSO.

A standard prescribing requirements for austenitic stainless steel welded pipe, large diameter (ASME SA-358 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M3-7T, dated July 1971. (JRD)

4001 (TID/SNA-1710) ENGINEERING OPERATIONS REPORT: 75K NERVA NOZZLE MATERIAL AND BRAZING PROCESS SELECTION. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 12 Apr 1972. 126p. Dep. NTIS $9.50.

Results of test programs to evaluate materials and processes for fabrication of rocket nozzles for NERVA are presented. Candidate materials include Armco 22-13-5, AISI 347, and Hastelloy X. It is recommended that Armco 22-13-5 be used as the nozzle jacket material, and AISI 347 as the coolant channel material. Recommended brazing procedures are also included. (JRD)

4002 (TID/SNA-2075) STATISTICAL ANALYSIS OF 347 STAINLESS STEEL AND HASTELLOY-X FATIGUE TEST RESULTS. Mihanovich, A. J. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 18 Oct 1971. 13p. Dep. NTIS $4.00.

A series of fatigue tests were performed on specimens of 347 stainless steel and Hastelloy-X at three temperature levels: 100°F, 1400°F, and 1600°F. The purpose of the statistical analysis of the resultant test data was to develop estimates of the relationships between total axial strain and the fatigue life (in terms of cycles to failure) at each of the three temperature levels for both materials. In addition, of interest were the corresponding 99/95 limits (numbers of cycles which 99% of the specimens exposed to a fixed strain level could be expected to survive with a confidence level of .95). The results of the statistical analysis indicate that the relationships between log percent total strain and log fatigue life can be represented adequately by straight lines in all cases except one (at 1000°F the 347 stainless steel results were found to be best represented by a quadratic relationship between log percent total strain and log fatigue life). At the two lower temperature levels (1000°F and 1400°F) the 347 stainless steel specimen generally exhibited longer fatigue lives than the Hastelloy specimens both in terms of mean expected life and 99/95 life. At the 1600°F temperature level, however, the two materials exhibited essentially equivalent mean lives while the Hastelloy-X specimens exhibited slightly higher 99/95 lives. (auth)

4003 (TID/SNA-2080) STUDIES LEADING TO DESIGN CRITERIA FOR STORAGE CONDITIONS. Derow, H. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 17 Mar 1971. 10p. Dep. NTIS $4.00.

A study was conducted to evaluate a request for stress relaxation data on NERVA materials used for bolts and springs. The following conclusions resulted: Spring relaxation data for BeCu indicates the critical temperature at which significant relaxation occurs, 225-250°F, is within the regime of the maximum NERVA storage temperature and at high preload stresses could be a problem; stress relaxation data on A-286 and Alloy 718 bolt materials at temperatures much below 1000°F are not available; therefore, tests must be performed if the data requested is to be provided and the tests must be conducted so that all effects inherent in bolted component design and assembly procedures contribute to the determined relaxation value. (auth)

4004 (TID/SNA-2104) NERVA TENSILE TEST REPORT. Fink, A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 26 Jul 1971. 54p. Dep. NTIS $5.75.

The susceptibility to embrittlement by high purity 1200 psi gaseous hydrogen was experimentally investigated for a series of materials under consideration for use in the Nerva Engine Program. The alloys included phosphor bronze, 22-13-5 stainless steel, AISI 9310, Inconel 718, and Type 301 stainless steel. The data indicate no measurable affect for phosphor bronze or 22-13-5 stainless steel, a slight affect for Inconel 718, and a marked affect for AISI 9310 and Type 301 stainless steel. A total of 32 constant strain-rate tests were conducted. All tests

were run at room temperature except for 6 AISI 9310 specimens which were run at -320°F. Control tests were conducted with helium gas instead of hydrogen. (auth)

4005 (TID/SNA-2106) MATERIALS DATA RELEASE. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 16 Aug 1971. 11p. Dep. NTIS $4.00.

Data on mechanical properties including compressive yield strength, compressive elastic modulus, Poissons ratio, hardness, and density are tabulated for 440C stainless steel. (JRD)

4006 (WANL-TMI-1682) THERMAL SHOCK TEST SPECIMEN. Eggers, A. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 7 Jun 1966. 11p. Dep. NTIS $4.00.

An analysis of the stress distribution in a failed Be specimen is presented. Results are presented in figures showing temperature distribution in the specimens and maximum stress as a function of time for eight specimens. A plot showing the axial stress required to propagate a transverse crack in a specimen as a function of crack width and fracture toughness is also included. (JRD)

4007 (WANL-TMI-1797) LOW CYCLE FATIGUE TESTS ON BERYLLIUM REFLECTOR MATERIAL AT 140°R. Hengstenberg, T. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 Jun 1967. 9p. Dep. NTIS $4.00.

Results of strain cycling tests on Be specimens at 140°R are summarized. A relation based on total plastic strain range that fits the test data is proposed. Strain/cycle data are tabulated and low cycle fatigue data on Be are presented in graphs. (JRD)

4008 (Y-1974) CHARACTERIZATION OF THE ANELASTIC AND THERMOELASTIC PROPERTIES OF A URANIUM–NIOBIUM–ZIRCONIUM ALLOY. Warner, T. D.; Winslow, F. R.; Hulsey, W. J.; Ammons, A. M.; Koger, J. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 12 May 1975. Contract W-7405-eng-26. 27p. Dep. NTIS $4.00.

Anelastic and thermoelastic properties of the uranium-7.5 niobium-2.5 zirconium alloy have been measured by four types of tests: (1) effect of plastic strain on the shape of the stress-strain curves as a function of the permanent strain for two levels of hydrogen content, (2) a study of the hysteresis loop as a function of the number of stress cycles, (3) measurement of the springback of plastically deformed specimens as a function of time, and (4) measurement of the springback of elastically deformed specimens as a function of time. Possible mechanisms have been proposed for the results of these tests, and a set of critical experiments has been suggested to elucidate this behavior. (auth)

4009 (Y-1985) DIRECTIONALLY SOLIDIFIED URANIUM–SILICON HYPOEUTECTIC COMPOSITE. Anderson, R. C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 6 May 1975. Contract W-7405-eng-26. 13p. Dep. NTIS $4.00.

When uranium–0.763 wt percent silicon (hypoeutectic) is directionally solidified, an in-situ composite is formed. This composite must be heat treated to decompose the U_3Si_2 (formed during solidification) to U_3Si in order to achieve the increased strength, ductility, and modulus of elasticity that the composite is capable of exhibiting. The mechanical properties of this hypoeutectic composite are lower than for high-strength uranium alloys. (auth)

4010 OPTICAL PROPERTIES OF THIN Au–Cr FILMS AND THEIR APPLICATION TO SOLAR ENERGY CONVERSION. Fuschillo, N.; Lalevic, B.; Slusark, W. Jr.; Delahoy, A. (Rutgers Univ., New Brunswick, NJ). J. Vac. Sci. Technol.; 12: No. 1, 84-87(1975).

Opaque Au and Au–Cr films were produced by rf triode sputtering onto a glass substrate at 150°C. Cosputtering of Au and Cr films has extended the solubility limits of Cr in Au from 19 at. percent to 48 at. percent Cr. Electron microscopy showed polycrystallinity in the entire solubility range and electron microprobe analysis confirmed compositional uniformity of films. Reflectance measurements were made in the range 0.3–15 mu. Reflectance data were analyzed by the Kramers–Kronig method to obtain the optical constants n, k, $epsilon_1$, and $epsilon_2$. Good agreement is shown with the previous single crystal data on Au–Cr (up to 19 at. percent Cr). The reflectance data are used to calculate alpha/epsilon ratio which is applied to the solar energy collector surfaces. Reflectance and transmittance data for very thin Au and Au–Cr films (100–400 A) are used to calculate the figures of merit for the heat mirror type solar-thermal energy collector design. (auth)

4011 CREEP STRENGTH IN STEEL AND HIGH-TEMPERATURE ALLOYS. Proceedings of a Meeting Held at Sheffield, England, September 20–22, 1972. London; Metals Society (1972). 276p. £10.

Thirty-three papers are presented in sessions entitled: fundamental and structural aspects of creep strength, engineering aspects of creep, microstructure and creep of austenitic steels and Ni-based alloys, microstructure and creep of ferritic steels. Two papers in the first session, fifteen in the third, and one in the last were in NSA scope, and separate abstracts were prepared for them. (UK)

For abstracts of individual papers see: 4012–4028 and 4096.

4012 RECOVERY-CREEP MODEL BASED UPON DISLOCATION DISTRIBUTIONS. Lagneborg, R. (Royal Inst. of Tech., Stockholm); Forsen, B. H.; Wiberg, J. pp 1-7 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

A recovery-creep model which makes allowance for the distribution of dislocations in the material is described. In agreement with microscopic observations, it is assumed that the dislocations exist in a three-dimensional network with a distribution of link sizes. The dislocation structure may then be described by a frequency function, $\phi(l)$, with the implication that $\phi(l) \cdot dl$ is the number of links with sizes between l and l + dl. During creep the distribution of link sizes will at any given moment be subjected to changes caused by different physical processes–release of dislocation links by stress-assisted thermal activation, supply of new dislocation links due to the expansion of the released links and their final arrest against neighbouring parts of the network, and recovery of the dislocation network. The recovery process is considered to be a climb-controlled shrinkage of small meshes in the network, and a growth of the large ones, in analogy with the process of grain growth. The model expresses these three processes quantitatively and is, therefore, able to generate the frequency function at any given time during the creep process. The creep rate may then be expressed in terms of the frequency function. The importance of describing the dislocation structure as a distribution for the concepts of mobile and immobile dislocations is discussed. (auth)

4013 STRUCTURAL STABILITY DURING HIGH-TEMPERATURE CREEP. Sellars, C. M. (Univ. of Sheffield, Eng.). pp 20-30 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Structural changes during creep of steels and nickel-based alloys are compared with changes that arise from long-term exposure at high temperatures. It is shown that the matrix structure developed depends primarily on the initial dislocation structure and the interparticle spacing, but the stability of interparticle spacing varies greatly from system to system. Changes in matrix structure influence the rates of coarsening and transformation of second-phase particles, particularly when these are carbides. This leads to complex effects of creep on the stability of carbides in martensitic or bainitic steels. The mechanisms involved in the interactions between matrix structure and particle stability are still uncertain. (auth)

4014 DISLOCATION DISTRIBUTIONS DURING CREEP AND RECOVERY OF A 20% Cr–35% Ni STEEL AT 700°C. Oden, A.; Lind, E.; Lagneborg, R. (Royal Inst. of Tech., Stockholm). pp 60-66 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The distribution of link lengths in the network-like dislocation structure produced during creep and recovery were measured in a 20% Cr–35% Ni steel at 700°C. Changes occurring during pure recovery of a dislocation structure created during creep could, above a certain dislocation density, be described as a gradual reduction of the dislocation density ρ with time t according to $1/\rho - 1/\rho_0 = 2M\tau t$, where M is the mobility of a climbing dislocation and τ is the dislocation-line tension. Change of the dislocation distribution occurred by a simple scaling of the structure. During creep the dislocation distributions changed according to a more complicated pattern. From the measured distributions during creep, the densities of the mobile and immobile dislocations were evaluated. (auth)

4015 SOME OBSERVATIONS ON THE INFLUENCE OF CARBON AND NITROGEN ON THE CREEP BEHAVIOR OF AISI 316 TYPE AUSTENITIC STAINLESS STEELS. Alden, G. (Institutet foer Metallforskning, Stockholm); Aronsson, B. pp 67-70 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The creep and creep-rupture properties of two steels with 17.5% Cr, 12% Ni, 2.5% Mo, one containing 0.05% C and 0.07% N, the other containing 0.02%C and 0.17%N, were determined at temperatures of 600 to 650°C and stresses of 90 to 230 MN/m^2 (6 to 15 tons/in.^{2}). Within this range, the steel with the lower N content displays a larger primary strain, while the stress and temperature dependence of the secondary creep rate is similar for both steels. However, for the same rate, the high-N steel exhibits a stress ~30 to 50 MN/m^2 higher, or a temperature ~25°C higher than the low-N steel. The higher creep-rupture strength, corresponding to ~50 MN/m^2 at 10,000 h, depends mainly on the smaller creep rate. Electron microscopy studies have confirmed earlier observations that carbon is mainly present as $M_{23}C_6$ particles, whereas nitrogen, at the concentrations studied, is in solid solution or in very small precipitates. The influence of the two interstitial elements on the creep properties of AISI 316 type steels is briefly discussed. (auth)

4016 SECONDARY CREEP DEFORMATION IN 18% Cr–10% Ni STEEL. Beckitt, F. R.; Banks, T. M.; Gladman, T. (British Steel Corp., Rotherham, Eng.). pp 71-77 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The stress and temperature dependencies of the secondary creep rate were determined for two 18% Cr–10% Ni steels containing 0.015% C and 0.056% C respectively. The higher carbon steel and the lower carbon steel at stresses above ~30 N/mm^2 showed a power-law stress dependence and a temperature dependence consistent with a volume diffusion controlled mechanism, as is frequently found with creep tests conducted at above ~0.5 T_M. At low stresses in the low-carbon steel, however, a linear stress dependence and a temperature dependence consistent with a grain-boundary diffusion-controlled mechanism, such as is found with Coble creep, were observed. (auth)

4017 MICROSTRUCTURAL CHANGES OCCURRING DURING THE CREEP DEFORMATION OF A SIMPLE AUSTENITIC STEEL AT 600°C. Keown, S. R. (Univ. of Sheffield, Eng.). pp 78-85 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Interrupted creep tests on a 17%Cr–26%Ni–0.03%C steel were carried out to investigate the microstructural changes occurring along a conventional elongation/time creep curve. Transmission electron microscopy was used to reveal the dislocation reactions and precipitation processes occurring at six positions along the creep curve up to fracture after 1829 h. Primary creep was associated with grain-boundary precipitation of $Cr_{23}C_6$ with no evidence for matrix precipitation. Planar dislocation arrays possibly associated with solute atmospheres appeared to be responsible for the decreasing creep rate. Secondary creep appeared to be controlled by heavy dispersions of small, dislocation nucleated precipitates of $Cr_{23}C_6$ in the matrix which clearly restricted dislocation movement. Dislocations were generated at grain-boundary precipitates and as loops at matrix precipitates. There was no evidence for polygonization during the steady state, the dislocations still being distinctly planar, suggesting solute drag effects in addition to precipitation during secondary creep. Tertiary creep was associated with the coarsening of $Cr_{23}C_6$ precipitates and the formation of dislocation networks and sub-boundaries, with no evidence of planar dislocations. The relatively good creep strength of this low-carbon high-nickel alloy is attributed to the nickel reducing the solubility of $Cr_{23}C_6$ in austenite, giving the large volume fraction of matrix $Cr_{23}C_6$ precipitates observed in the microstructure. (auth)

4018 TEMPERATURE DEPENDENCE OF STEADY-STATE CREEP IN 20% Cr–25% Ni–Nb STABILIZED STAINLESS STEEL. McLaughlin, I. R. (Central Electricity Generating Board, Berkeley, Eng.). pp 86-90 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The temperature dependence of the steady-state creep rate in 20%Cr–25%Ni–1%Nb stainless steels was measured over a stress range of 70 to 160 N/mm^2 and at an average temperature of 750°C. Activation energy values were found to decrease with increasing applied stress and to be greater than that for self-diffusion over the whole stress range. The behavior is explained by taking account of the temperature dependence of the stress exponent which arises from the dependence on temperature of the internal back stress due to the NbC precipitates. Alloys with different carbon levels were found to have slightly different creep properties. This behavior is rationalized by considering similarly the effect of NbC on the internal stress level. (auth)

4019 SOME FACTORS AFFECTING THE CREEP STRENGTH OF 20% Cr–25% Ni–Nb AUSTENITIC STEEL AT 750°C. Cook, J. D.; Harries, D. R.; Roberts, A. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 91-98 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The dependencies of the secondary creep rate at 750°C and 10,000 lb/in^2 (68.95 MN/m^{-2}) on the niobium content and solution-treatment temperature (1050 and 1150°C) were determined for 20%Cr–25%Ni steels containing 0.02 and 0.06(C + 6/7N). In addition, the effects of solution treatment followed by aging for 300 h at 850°C, and 10% cold work and aging on the creep rates of the 0.06%(C + 6/7N) steel were investigated. The creep rates of the 0.02%(C + 6/7N) steels were dependent on (grain size)$^{-3}$ and decreased with increasing Nb : (C + 6/7N) ratio. These respective observations are consistent with a grain-boundary diffusion creep mechanism and the inhibition of dislocation creep by solute drag or intragranular NbC precipitates. The evidence for a grain-boundary diffusion creep mechanism was more limited in the case of the 0.06%(C + 6/7N) steels. It is tentatively proposed that the creep rates of the 1050°C solution-treated steels are controlled by solute drag, while those of the 1150°C solution-treated and aged, and cold-worked and aged, steels are controlled by dislocation–precipitate interactions. (auth)

4020 EFFECT OF NIOBIUM CONTENT ON THE STEADY-STATE CREEP ON STABILIZED 20% Cr–25% Ni AUSTENITIC STAINLESS STEELS. Adamson, J. M.; Martin, J. W. (Oxford Univ.). pp 99-105 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Six 20%Cr–25%Ni austenitic stainless steels were studied, the proportion of Nb being varied with two basic carbon levels (0.05 and 0.1 wt-%) to give hypo-, hyper-, and stoichiometric compositions for the precipitation of all the carbon as NbC. Specimens were crept in air under constant load conditions, and the effect of stress, test temperature, alloy composition, grain size, and state of precipitation were examined. A correlation was attempted between the microstructure observed by thin foil electron microscopy, and the steady-state creep rate. The latter is increased with increased pre-aging at the creep temperature before testing, the effect being greatest over the initial 100 h when greatest precipitation occurs. The steady-state creep rate ($\dot{\epsilon}_s$) is dependent on the grain size (d), and a relationship $\dot{\epsilon}_s \propto d^{-1}$ applies to the hypostoichiometric alloys. The log of stress dependence against that of the minimum creep rate is not linear at high stress (~120 MN/m^2). The dependence is 2 to 3 times that at lower stresses (~100 MN/m^2). The apparent activation energy for creep measured at various stress levels is dependent on the stress. Results are interpreted with respect to the solute drag, recovery, and grain-boundary theories of creep, and their applicability to this system is discussed. (auth)

4021 EFFECT OF CREEP STRAIN ON STACKING-FAULT PRECIPITATION IN Nb-STABILIZED 20% Cr–25% Ni AUSTENITIC STAINLESS STEEL. Adamson, J. P.; Martin, J. W. (Oxford Univ.). pp 106-110 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Two 20%Cr–25%Ni austenitic stainless steels, Nb-stabilized and of differing carbon content (0.1 and 0.05 wt%C), were aged between 650 and 750°C. Precipitation of NbC upon matrix dislocations takes place increasingly in the form of stacking-fault precipitation as the degree of supersaturation of the alloy is increased. At extended aging times a new form of $M_{23}C_6$ precipitation has been observed–this is in the form of plates in association with some of the stacking faults. On continued aging the $M_{23}C_6$ redissolves. When the precipitation processes occur during creep deformation, it was found that at 750°C the stacking-fault precipitation of NbC was promoted, whereas at 650°C the development of NbC precipitates on dissociated dislocations is prevented. Results are discussed in terms of the rates of change of supersaturation in these alloys under the experimental conditions. (auth)

4022 STRESS VARIED CREEP ON 20% Cr–25% Ni–Nb STABILIZED AUSTENITIC STAINLESS STEEL. Wilson, E. G. (United Kingdom Atomic Energy Authority, Springfield, Eng.). pp 111-121 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Nuclear fuel cladding in the latest generation of civil advanced gas-cooled reactors may be subjected to complex stress/strain cycles resulting from the variations in reactor power levels associated with load-following operation. It was, therefore, necessary to investigate the fundamental creep behavior under conditions of varying and reversing stress. The experimental techniques are briefly described. Results are presented for 20%Cr–25%Ni–Nb stabilized austenitic steel cladding, tested in the range 13.8 to 103 MN/m^2 at temperatures of 850 to 600°C with stress variations of two main types–tension followed by stress removal after which the creep-strain recovery observed was essentially anelastic, and tension alternating with equal (time) periods of compression. The latter was achieved by reversing the axial stress on the tubular specimens. A pronounced Bauschinger effect followed the first stress reversal for tests started in either tension or compression. After several cycles a further decrease in creep resistance was apparent at the lower temperatures, but above 750°C the creep resistance increased slightly after the initial Bauschinger softening. Thin foil electron microscopy has revealed that the softening after many reversals is due to a dislocation annihilation process. It is shown that both the Bauschinger effect and creep recovery can be explained as anelastic behavior for which a dislocation recoil mechanism is proposed. The significance of the internal stress manifested by anelasticity is discussed, and a general expression for creep is proposed which takes account of anelastic behavior. (auth)

4023 LOW-STRESS CREEP TESTS OF NIOBIUM-STABILIZED AUSTENITIC STEELS. Silcock, J. M.; Willoughby, G. (Central Electricity Research Labs., Leatherhead, Eng.). pp 122-133 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The creep behavior of fully aged, niobium-stabilized austenitic steels was studied at stresses below 50 N/mm^2 and the effect of different NbC contents and various heat treatments examined. The temperature and stress were changed during the secondary creep period so that values of the apparent activation energy and the stress dependence of the creep rate were obtained from the individual specimens. The apparent activation energy for creep was similar to self-diffusion, the stress exponent was generally about 3, and recovery periods were observed on decreasing the stress. The creep rate increased as the niobium carbide particle density decreased. However, at the higher NbC contents, small grain sizes, and low stresses the effect of particle dispersion was less important, and this was attributed to an increase in grain-boundary sliding. The grain size dependence of the creep rate was high ($d^{-1.5}$). This was attributed to an increase in grain-boundary sliding and coarsening of particle dispersion at small grain sizes, but may also indicate that easier accommodation of grain-boundary sliding occurs at small grain sizes. (auth)

4024 EFFECT OF NIOBIUM CARBIDE ON THE CREEP-RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEELS. Keown, S. R.; Picker, F. B. (Univ. of Sheffield, Eng.). pp 134-143 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

An examination was made of the effect of Nb and C content on the creep-rupture properties of 18%Cr–13%Ni austenitic stainless steels. The rupture life increased with increasing solution-treatment temperature, and at any given carbon content, maximum rupture life and minimum rupture ductility occurred at or about the stoichiometric Nb/C ratio. The maximum rupture life for any given solution-treatment temperature occurred for stoichiometric compositions of Nb_4C_3. With increasing Nb and C contents along the stoichiometric line, the rupture life first increased as the amount of undissolved NbC increased, but this trend was reversed at the highest Nb and C contents. A statistical analysis showed that the rupture life was primarily controlled by the amount of NbC available for precipitation, and by the amount of undissolved NbC. The rupture ductility decreased as the amount of NbC available for precipitation increased, but was largely unaffected by the undissolved NbC. The metallurgical interpretation of these results has been discussed, and it is concluded that the precipitated NbC was the major factor controlling the rupture life, while solid-solution effects were of less importance. (auth)

4025 AGING AND CREEP BEHAVIOR OF A Cr–Ni–Mn AUSTENITIC STEEL. Asbury, F. E.; Willoughby, G. (Central Electricity Research Labs., Leatherhead, Eng.). pp 144-151 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

The creep behavior of a 16%Cr–10%Ni–6%Mn–Mo–V–Nb–B steel was investigated at 650°C in constant-load and constant strain-rate tests. A wide range of initial solution and aging heat treatments were given to the material. At high levels of stress and initial supersaturation, the strength was influenced by precipitation of niobium carbide during the early stages of straining. The kinetics of the loss of this strengthening effect with pre-aging were consistent with those to be expected for niobium-solute depletion. At low stresses the precipitation of sigma phase, and the pre-existing niobium carbide and associated dislocations were the main factors affecting creep strength. The sigma phase was found to remove potential strengthening elements, particularly molybdenum, from solution. The rate of sigma precipitation was strongly dependent on grain size. It is concluded that the complexity of these effects must hinder the accurate prediction of the long-term creep-rupture behavior. (auth)

4026 CREEP STRENGTH OF 17% Cr–11% Ni–2.5% Mo AUSTENITIC STEEL STABILIZED TITANIUM. Williams, T. M.; Harries, D. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 152-158 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Type 316 austenitic steels containing 0.049 wt% carbon and 0, 0.10, 0.26, and 0.45 wt% titanium, and 0.090 wt% carbon and 0, 0.25, 0.50, and 0.75 wt% titanium, were creep-rupture tested at 650°C and 28,000 lb/in^2 (193 MN/m^2) in various conditions of prior treatment. The secondary creep rates of the steels tested in the 1050 or 1150°C solution-treated conditions decreased progressively with increasing titanium content. It is suggested that the creep of the higher titanium steels is controlled by drag of excess titanium solute atoms which are strongly bound to dislocations. The creep strengths of the 0.049 and 0.090 wt % carbon steels tested in the 1050°C solution-treated and 20% cold-worked, and 1050°C solution-treated 20% cold-worked and aged at 650°C for 500 h conditions exhibit maxima at ~0.25 wt % titanium. The electron microscope observations, and the solubility data for $M_{23}C_6$ and TiC show that the creep strengths are dependent on the concentrations of precipitates nucleated on the dislocations induced by the prior cold working. It is inferred that the creep recovery observed in some of these steels occurs by cross slip and not by dislocation climb. (auth)

4027 INFLUENCE OF STRUCTURE UPON THE NOTCHED CREEP STRENGTH OF A NICKEL-BASE ALLOY. Gayter, H. (Henry Wiggin and Co. Ltd., Hereford, Eng.); Nutting, J. pp 189-195 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Under most conditions of heat treatment, notched creep specimens of precipitation-hardened nickel-base alloys show an improvement in creep rupture life over those of plain specimens. However, it is possible to develop heat treatments in which notched creep specimens give shorter lives than plain specimens. A metallographic investigation was undertaken of the structural changes occurring during constant load creep testing of Nimonic alloy 90, heat treated to give either notch weakening or notch strengthening. It was found that notch weakening occurs if the creep strength of the grains is high, and that their creep strength increases during the progress of the test. Notch strengthening, on the other hand, occurs when the creep strength of the grains is low and their creep strength decreases during creep exposure. The heat treatments used also modify the carbide morphology at the grain boundaries, and the changes in this during creep exposure can be linked with changes in grain morphology to give an explanation, in terms of microstructural parameters, of the notched creep weakening mechanisms. (auth)

4028 DISPERSION-STRENGTHENED FERRITIC ALLOYS FOR HIGH-TEMPERATURE APPLICATION. Snykers, M.; Huet, J. J. pp 237-241 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

It has been shown that ferritic structures are much less sensitive to high-temperature embrittlement than austenitic ones; such steels are proposed as possible canning materials for fast reactor fuel elements. As at present commercial ferritic steels do not have adequate strength at the operating temperature, which may be as high as 700°C, improvement of the high-temperature creep

properties was necessary. This was first achieved by adding 3 to 5% titanium to a more conventional Fe–13Cr–1.5Mo alloy. A still better strength is obtained when an oxide dispersion is provided in that matrix. The dispersoid is made by powder-metallurgy techniques. The influence of TiO_2 and Y_2O_3 additions on the 700°C stress-rupture characteristic was investigated. Rupture times comparable with the strongest austenitic steels were obtained without impairing the ductility of the alloys. Investigations were carried out in order to explain the strengthening mechanisms which are due partly to a coherent x-phase containing Fe, Cr, Mo, and Ti, and partly to the oxide dispersion. (auth)

4029 STATE DIAGRAMS OF THE SYSTEM Ni_3Al, Ni_3Nb, AND Ni_3Ta. Alikhanov, V. A.; Pyatnitskii, V. N.; Sokolovskaya, E. M. Vestn. Mosk. Univ., Ser. II, Khim.; 15: No. 6, 698-701 (1974). (In Russian).

The interaction of the intermetallic compounds Ni_3Al, Ni_3Nb and Ni_3Ta in the $Ni_3Al-Ni_3Nb-Ni_3Ta$ system was studied by the thermal and microstructure analyses. The isotherms of the liquid and solid surfaces were plotted for the pseudoternary system $Ni_3Al-Ni_3Nb-Ni_3Ta$. (auth)

4030 PHASE EQUILIBRIA IN THE Nb–V–Ga SYSTEM AT 800°C. Kreidenko, F. S.; Markiv, V. Ya.; Sokolovskaya, E. M. Vestn. Mosk. Univ., Ser. II, Khim.; 15: No. 6, 748-750 (1974). (In Russian).

The isothermal section of the Nb–V–Ga system has been plotted. The new intermetallic compound Nb_2VGa was detected. (auth)

4031 CREEP STRENGTH (BY HOT HARDNESS) OF URANIUM ALLOYS. Containing 15 At.-% of Niobium + Molybdenum. Makhova, V. A.; Gomozov, L. I. pp 97-99 of Stroenie i Svoistva Splavov dlya Atom. Energ. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Creep strength tests were made on U alloys containing (Nb + Mo) 15 at.-% at 700, 800, and 900°C with loading times of 1, 3, and 10 min. The concentration dependence of creep rate was generally opposite to that of the change in hardness. The creep activation energy, Q, calculated from $VH \sim \exp[-Q/RT]$, was noticeably above that for self diffusion in γU and relatively low-alloyed U. Values of Q under tensile stress for alloys with optimum alloying, i.e., Nb : Mo = 1 : 1 (at.-%), obtained by cyclic temperature increases, were close to those obtained by the long-term hot hardness method. (Metals Abstr.)

4032 MEASUREMENT OF DIFFUSION IN TUNGSTEN METAL FROM GAS PHASE SOURCES BY MEANS OF AUTORADIOGRAPHY. Bartha, L.; Kozma, L. (Kozponti Fizikai Kutato Intezet, Budapest). Int. J. Appl. Radiat. Isotop.; 26: No. 4, 219-220(Apr 1975).

A method of measuring the volume-diffusion of Ta in W at temperatures between 2391 and 3197°C is described which uses the oversaturated vapor of the diffusing metal as a diffusion source. ^{182}Ta was used as a radioactive tracer and the diffusion profile was detected by a microautoradiographic technique. (UK)

4033 CREEP RESISTANCE OF LOW ALLOY URANIUM ALLOYS CONTAINING ZIRCONIUM, NIOBIUM, MOLYBDENUM, AND ALUMINUM. Gomozov, L. I.; Lyutina, E. M.; Ivanov, O. S. pp 103-111 of Stroenie i Svoistva Splavov dlya Atom. Energ. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The effect of small additions of Zr, Nb, Mo, and Al on the rate of the steady state creep of U in relation to heat treatment regime and purity of the original U was studied using bend creep tests at 500, 550, 600, 630, and 650°C. The presence of Zr, Nb, or Mo at ~0.2 at.-% lowers the steady state creep rate by an order at 500°C and by 3 orders at 600°C maximum strengthening of technical U is attained with the carbide-forming elements Zr and Nb at 0.2 to 0.4 at-% as a result of precipitation during annealing of the respective dispersed carbides which form from UC produced during non-equilibrium crystallization. The intensity of dispersion strengthening increases in the order U–Mo, U–Zr, U–Nb, U–Zr–Nb, U–Nb–Mo, and U–Nb–Al. Quenching of U alloys, that tend to β phase stabilization, leads to accumulation of damage in the $\beta \rightarrow \alpha'$ transformation which increases the creep rate. The microstructure of specimens tested to creep fracture at 600°C indicates that in those alloys with a disperse phase the low temperature deformation processes are shifted towards higher temperature. (Metals Abstr.)

4034 EFFECT OF COVERING AND LIQUID MEDIA ON THE PLASTIC DEFORMATION OF TUNGSTEN. Amonenko, V. M.; Azhazha, V. M.; Shapoval, B. I.; Bondarenko, N. P.; Kovtun, G. P. Fiz. Khim. Obrab. Mater.; No. 1, 102-122(1975). (In Russian).

A comparison is carried out of the results of the parallel effect of a liquid, surface-active substance and of a titanium film on the impact strength and amplitude-dependent, internal friction of polycrystalline tungsten. It is shown that the possible decrease of the surface energy of tungsten under the effect of a titanium film cannot serve as a determining factor in improving the mechanical properties of tungsten. (SJR)

4035 FAR-INFRARED ABSORPTION IN SMALL METALLIC PARTICLES. Tanner, D.B.; Sievers, A.J. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14850); Buhrman, R.A. Phys. Rev. B 11: No. 4, 1330-1341 (15 Feb 1975).

Far infrared transmission measurements were made on powder samples of Cu, Al, Sn, and Pb. The diameter of the particles ranged from 65 to 350 Å. All of the samples showed absorption which was very small at low frequencies and which increased more or less linearly as the frequency increased. There was no change in the absorption as the temperature was varied from 1.2 to 20 K. For the smaller particles absorption curves calculated from the modified theory of Gor'kov and Eliashberg give a good description of the data, although clear choices between different energy-level ensembles cannot be made. Our measurements provide direct evidence that, for superconducting particles of diameter ≈ 100 Å and mean energy-level spacing $\approx kT_c$, the energy gap structure in the density of states is either much attenuated or is completely absent. (auth)

4036 INTERPOLATION SCHEME FOR THE COHESIVE ENERGIES FOR THE LANTHANIDES AND ACTINIDES. Johansson, B. (FOA HE 2, Stockholm 80, Sweden); Rosengren, A. Phys. Rev. B 11: No. 4, 1367-1373 (15 Feb 1975).

An interpolation scheme for the binding energies is shown to give a good account for the cohesive energies of the rare-earth metals. From this the divalent nature of europium and ytterbium can be concluded. The same method is applied to the actinide elements. The observed deviations from experiment are interpreted in terms of itinerant $5f$ states. Further, a divalent metallic character of the heavier actinide elements, starting with einsteinium, is predicted. (auth)

4037 PARAMETRIZATION OF TRANSITION-METAL FERMI-SURFACE DATA. Ketterson, J.B. (Argonne National Laboratory, Argonne, Illinois 60439 and Northwestern University, Evanston, Illinois 60201); Koelling, D.D.; Shaw, J.C.; Windmiller, L.R. Phys. Rev. B 11: No. 4, 1447-1459 (15 Feb 1975).

The phase shifts associated with a muffin-tin approximation of the crystal potential were used as parameters to represent the Fermi surface of the body-centered-cubic transition metals molybdenum and tungsten. The band-structure formalism employed was the relativistic Korringa-Kohn-Rostoker method and the phase-shift parameters were determined by a least-squares fit to extremal cross-sectional areas obtained from de Haas–van Alphen data. Five-parameter fits which employed the $s_{1/2}$, $p_{1/2}$, $p_{3/2}$, $d_{3/2}$, and $d_{5/2}$ phase shifts had root-mean-square errors which exceeded the estimated experimental error. Inclusion of the f phase shifts did not significantly reduce the discrepancy. Therefore, a formalism was developed and applied to include the nonspherical (inside-muffin-tin) corrections of the potential with the fits truncated at d-wave scattering. With the additional two parameters thus introduced an rms error consistent with the experimental error was obtained. As in the earlier work on noble metals, the rms error was found to be quite insensitive to the value of the Fermi energy used. (auth)

4038 MEASUREMENT OF THE FLUCTUATION HEAT CAPACITY OF NIOBIUM IN A MAGNETIC FIELD. Farrant, S.P.; Gough, C.E. (Department of Physics, University of Birmingham, Birmingham B15 2TT, England). Phys. Rev. Lett. 34: No. 15, 943-946 (14 Apr 1975).

The heat capacity of niobium at constant magnetic induction has been measured in the immediate neighborhood of $T_c(B)$ with millikelvin temperature resolution. An enhanced heat capacity attributable to fluctuations is observed both above and below $T_c(B)$. The temperature dependence throughout the transition region can be described over a wide temperature range by a universal curve with a temperature scale uniquely determined by measured thermodynamic parameters. (auth)

4039 ANISOTROPIC HYPERFINE INTERACTIONS IN GADOLINIUM METAL. Bauminger, E.R.; Diamant, A.; Felner, I.; Nowik, I.; Ofer, S. (Racah Institute of Physics, The Hebrew University, Jerusalem, Israel). Phys. Rev. Lett. 34: No. 15, 962-965 (14 Apr 1975).

Mössbauer studies of the 86-keV transition of Gd^{155} in $Gd_{1-x}R_x$ compounds yield the hyperfine interaction parameters as a function of lattice dimensions and the angle θ between the magnetization and the c axis. The magnetic hyperfine field is anisotropic, $H_{\text{eff}}(\theta = 28°)/H_{\text{eff}}(\theta = 47°) = 1.13$. The ratios between the electric field gradients in various metallic crystals are in agreement with the point-charge model. The absolute values of the gradients are about twice the theoretical values. (auth)

4040 FIELD ELECTRON CATHODE STABILITY STUDIES: ZIRCONIUM/TUNGSTEN THERMAL-FIELD CATHODE. Swanson, L.W.; Martin, N.A. (Linfield Research Institute, McMinnville, Oregon 97128). J. Appl. Phys. 46: No. 5, 2029-2050 (May 1975).

The emission angular distribution, total energy distribution, noise spectrum, and emitter life have been measured for the W/Zr thermal-field cathode. The results give an emitter life in excess of 1000 h at T=1350 to 1450 K, $P \geq 2\times10^{-8}$ Torr, and a total current of ≈100 μA. A low-noise highly confined beam long the (100) direction can be obtained. A source brightness of 10^{10} A/cm² sr at 3 kV and an energy spread of less than 0.9 eV were measured under operational conditions. (auth)

4041 DISORDER RESISTIVITY OF GADOLINIUM-DYSPROSIUM ALLOYS AT T=0 °K. Yang, J.J. (Autonetics Division, Rockwell International Corporation, Anaheim, California 92803); Yang, T.T. J. Appl. Phys. 46: No. 5, 2229-2231 (May 1975).

The experimental spin-disorder resistivity of Gd-Dy alloys at temperatures above the magnetic transition point has been compared with Dekker's theoretical expression. The inter-Coulomb potential and the exchange coupling constants obtained from this comparison have been used to calculate the disorder resistivity of Gd-Dy alloys at T=0 °K. The agreement between calculated results and experimental data is reasonably good. (auth)

4042 FABRICATION OF FLEXIBLE SUPERCONDUCTING Nb_3Al TAPE. Harasyn, D.E.; Toth, L.E. (Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, Minnesota 55455). J. Appl. Phys. 46: No. 5, 2232-2236 (May 1975).

Flexible tapes of Nb_3Al were prepared by cold welding sheets of niobium and aluminum in a rolling mill followed by a brief high-temperature heat treatment. They were also prepared by a vapor deposition process followed by heat treatment under a high aluminum vapor pressure. Superconducting layers were typically 1 mil thick and had T_c's in the range 16–18 K. $J_c(H)$ measurements indicate that properly prepared Nb_3Al tapes can carry large current densities (8×10^4 A/cm² at 70 kOe). Present research shows that considerable metallurgical difficulties, associated with the high reaction temperatures and brittleness of the Nb_3Al phase, need to be overcome before these processes can become commercial. (auth)

4043 SUPERCONDUCTING PROPERTIES OF GETTER-SPUTTERED V_3Al THIN FILMS AS A FUNCTION OF SPUTTERING GAS, PRESSURE, AND SUBSTRATE TEMPERATURE. Schmidt, P.H.; Bacon, D.D.; Barz, H.; Cooper, A.S. (Bell Laboratories, Murray Hill, New Jersey 07974). J. Appl. Phys. 46: No. 5, 2237-2243 (May 1975).

Superconducting transition temperatures of V_3Al thin films prepared by getter sputtering have been found to vary significantly not only with variation of the deposition temperature, as previously reported, but also with variation of the deposition pressure and composition of the sputtering atmosphere. The film composition measured at T_c maxima obtained by varying the deposition temperature for nonoptimum pressures was found to depart significantly from the 3 : 1 stoichiometry. High-deposition pressures $P_D > 175$ mTorr are associated with films containing an excess of Al, while deposition pressures of less than 60 mTorr result in V-rich films. With near-optimum film deposition conditions for Ar, 155 mTorr pressure, and a deposition temperature of 800 °C, we have obtained a peak superconducting transition temperature of 11.8 °K. (auth)

4044 FLUX PINNING CENTERS IN SUPERCONDUCTING Nb_3Sn. Scanlan, R.M. (General Electric Corporate Research and Development, Schenectady, New York 12301); Fietz, W.A.; Koch, E.F. J. Appl. Phys. 46: No. 5, 2244-2249 (May 1975).

Very high critical current densities ($J_c=8\times10^5$ A/cm² at 4.2 K and 6 T) have been achieved in commercial Nb_3Sn tape and more recently in multifilamentary Nb_3Sn superconductors. The relative contributions of two types of pinning centers, grain boundaries and second phase particles, to flux pinning have been determined by correlating J_c with microstructure. It was found that grain boundaries were the only defect present in sufficient density to account for flux pinning in the multifilamentary Nb_3Sn material. The dependence of J_c on grain size was measured, and the relationship between pinning force and grain size is discussed in terms of current theories for flux pinning in type-II superconductors. (auth)

4045 ENHANCED SUPERCONDUCTIVITY AND LATTICE INSTABILITY IN Nb-Rh ALLOYS. Johnson, W.L.; Poon, S.J. (W. M. Keck Laboratory of Engineering Materials, California Institute of Technology, Pasadena, California 91109). J. Appl. Phys. 46: No. 5, 2325-2326 (May 1975).

Superconductivity with transition temperature above 10 °K has been observed in a new Nb-Rh intermediate phase. The new metastable phase is obtained by liquid quenching the binary alloy or by the addition of a small percentage of carbon to form a stable ternary alloy. (auth)

4046 HIGH-RATE PHYSICAL VAPOR DEPOSITION OF REFRACTORY METALS. Sherman, M.A. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Bunshah, R.F.; Beale, H.A. J. Vac. Sci. Technol. 12: No. 3, 697-703 (May 1975).

Molybdenum, niobium, and vanadium bulk deposits produced by high-rate physical vapor deposition techniques (HRPVD) were analyzed for impurity content, grain size and morphology, yield strength, hardness, and bend ductility. Yield strengths of Mo and Nb were comparable to those of wrought material having equivalent grain sizes, while the yield strength of vapor-deposited V was superior to that of wrought V because of its ultrafine (0.7 μm) grain size. Ultrafine-grained refractory metals, such as the V deposits produced in this study, may greatly reduce void formation and growth, which causes dimensional changes and degradation of mechanical properties in reactor structural components. It is suggested that HRPVD techniques may be used to prepare fine-grained materials having superior resistance to swelling induced by fast-neutron irradiation. (auth)

4047 DEPARTURE FROM KNUDSEN'S COSINE LAW DURING THE BOAT EVAPORATION OF INDIUM. Rawat, S.D. (Physical Research Laboratory, Ahmedabad-9, India). J. Vac. Sci. Technol. 12: No. 3, 725-726 (May 1975).

It is shown that Knudsen's cosine law for free molecular flow is not obeyed in the case of vacuum evaporation of indium for film deposition from Mo boats. (AIP)

4048 ADSORPTION AND DIFFUSION OF DEUTERIUM IN GOLD. Ionov, N.I.; Kompaneets, T.N.; Kostoyanov, A.I.; Kurdyumov, A.A. (A. A. Zhdanov State University, Leningrad). Sov. Phys.—Solid State 16: No. 9, 1654-1656 (Mar 1975).

The adsorption and diffusion of deuterium in gold were investigated by the direct flash and permeability methods using a pulsed time-of-flight mass spectrometer in recording changes of partial pressures. It was found that gold was impermeable to molecular deuterium because of the low probability of its dissociative chemisorption. The rate of penetration of atomic deuterium across gold was limited by the very low maximum solubility. Estimates were obtained of the sticking coefficients of the molecular and atomic deuterium. The activation energy of diffusion and of the penetration of deuterium into gold were determined. (auth)

4049 QUANTUM OSCILLATIONS OF THE LONGITUDINAL MAGNETORESISTANCE OF P—TYPE InSb. Bir, G.L.; Parfen'ev, R.V. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). Sov. Phys.—Solid State 16: No. 9, 1686-1692 (Mar 1975).

A theoretical and experimental investigation was made of the quantum oscillations of the longitudinal magnetoresistance of p-type InSb associated with the quantization of the light-hole energies in a magnetic field. It is shown that in a longitudinal magnetic field which quantizes the light holes oscillations are produced of the conductivity of the unquantized heavy holes, associated with the increase in the heavy-hole interband scattering when the Fermi level coincides with the light-hole Landau levels. An expression is derived for the oscillatory part of the heavy-hole conductivity in a magnetic field. The experimental results presented show that the first oscillatory maxima of the longitudinal magnetoresistance are due to the interband scattering of the heavy holes. This increase in the interband scattering of the heavy carriers into the Landau subbands of the light carriers is characteristic of semiconductors with degenerate bands. (auth)

4050 THERMAL DESORPTION AND THERMIONIC EMISSION OF LANTHANIDE FILMS ON A RHENIUM SURFACE. Ionov, N.I.; Medvedev, B.K. (A. A. Zhdanov Leningrad State University). Sov. Phys.—Solid State 16: No. 9, 1719-1721 (Mar 1975).

The heats of desorption of the atoms b_0 and the preexponential factors D in the kinetic thermal-desorption equation have been determined for 12 lanthanides by the method of temperature modulation of the adsorbent. A linear relationship was found between log D and b_0 (the compensation effect). The dependence of the thermionic current on the time of deposition of the lanthanides on the rhenium surface was measured for three of the elements (lanthanum, cerium, and thulium). (auth)

4051 SUPERCONDUCTING PROPERTIES OF INDIUM AT HIGH PRESSURES. Il'ina, M.A.; Itskevich, E.S.; Titov, A.V. (Institute of High-Pressure Physics, Academy of Sciences of the USSR, Moscow). Sov. Phys.—Solid State 16: No. 9, 1731-1732 (Mar 1975).

The effect of quasihydrostatic pressures up to ≃60 kbar on the critical temperature T_c and critical field H_c of superconductivity of indium was investigated. A change in the values of dT_c/dP and $(dH_c/dP)_{T=const}$ was found in the pressure range 32–40 kbar. This behavior of the critical fields and temperature is attributed to a change in the Fermi-surface topology of indium. (auth)

4052 TRANSPORT PROPERTIES OF SAMARIUM AT HIGH TEMPERATURES. Zinov'ev, V.E.; Gel'd, P.V.; Sokolov, A.L. (S. M. Kirov Ural Polytechnic Institute, Sverdlovsk). Sov. Phys.—Solid State 16: No. 9, 1776-1776 (Mar 1975).

The results are given of measurements of the temperature dependence of the thermal diffusivity of samarium between 550 and 1080°K and of the electrical resistivity of the same material between 290 and 1000°K. (AIP)

4053 TECHNIQUES FOR THE OBSERVATION OF GRAIN BOUNDARIES IN AN AUSTENITIC STAINLESS STEEL. Howell, P. R.; Jones, A. R.; Ralph, B. (Cambridge Univ., Eng.). J. Microscopy; 102: No. 3, 323-330(Dec 1974).

This paper discusses methods of analyzing grain boundary structure in a commercial alloy system using transmission electron microscopy of thin foils. The results illustrate how the fine scale structure of grain boundaries may be analyzed by employing weak beam imaging techniques and grain boundary diffraction effects. (auth)

4054 OBSERVATION OF PERIODICITY IN GRAIN BOUNDARIES. Bolin, P. L.; Bayuzick, R. J.; Ranganathan, B. N. (Vanderbilt Univ., Nashville). J. Microscopy; 102: No. 3, 355-360(Dec 1974).

Field ion microscopy and computer graphics techniques were utilized in studying the topography of a grain boundary in a W–1 wt % ThO_2 specimen. Perspective plots and stereographic Pole Plots of the surface were obtained. An examination of the perspective plots of the boundary surface in conjunction with the stereographic pole plot reveals a strong tendency towards periodicity in the grain boundary. Although no definite wavelength is noticed, an overall tendency towards periodicity is evident. Further the stereographic pole plot indicates the nature of the inclinations in the grain boundary surface. (auth)

4055 ELECTROLYTIC MAGNETIC Co-BASE ALLOYS. XV. Co–W–V Alloys Deposition. Kharlushene, V. E.; Rachinskas, V. S.; Matulis, Yu. Yu. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B; 5: No. 84, 51-60(1974). (In Russian).

It was determined that by increasing VO_3^- concentration (c) and decreasing $CoSO_4$ and WO_4^{2-} c in the electrolyte, the deposition potential of alloys is shifted to more negative values and the current efficiency (η) decreases. It was established that increasing VO_3^- c in the electrolyte, the percentage of W and V in the deposits, the coercive force (H_c) and coefficient of hysteresis loop (β) increase, but the residual magnetism (I_r) decreases. Increasing WO_4^{2-} c and decreasing $CoSO_4$ c in the electrolytes the content of W in the deposits decreases and H_c and β pass through the maximum. The cathodic current density decreasing and both pH and temperature increasing the content of W in the deposits and H_c increases and I_r decreases. On the basis of the experimental data, the conclusion is drawn that during electrolysis of $CoSO_4$ solutions containing WO_4^{2-} and VO_3^- the chemical composition of the deposits and magnetic properties depends on the intensity of H_2 evolution and on the degree of alkalization of precathodic layer. (9 fig) (auth)

4056 CREEP OF SOME URANIUM ALLOYS IN THE GAMMA REGION. Gomozov, L. I.; Makhova, V. A.; Ivanov, O. S. pp 111-118 of Stroenie i Svoistva Splavov dlya Atom. Energ. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Tension and compression creep data (1-2 kg/mm²) were obtained for U 85 at. % alloys containing Zr, Nb, Mo, and Ti additions either singly or in combination, in the γ region, at 760–880°C. In the case of binary alloys the creep rate ϵ fell in the order Zr, Ti, Nb, Mo which does not agree with either the mp or diffusion coefficient order. Calculations show that the values of ϵ fall exponentially with increase in elastic distortions in the γ solid solutions, while the hot hardness increases linearly. Within any one system $\log \epsilon \propto \log \tilde{D}$ ($\tilde{D}$ = interdiffusion coefficient). The creep activation energy, Q_n, is close to that for interdiffusion or self-diffusion. Creep is controlled by areas strengthened by dislocation pile-ups at grain boundaries, and the sensitivity to stress, n, is close to 2. An increase in the deformation rate leads to an increase in the contribution of the grain to the creep process and to some increase in Q_n and n. Dispersion strengthening of the grains lowers ϵ by 2–3 orders with n approximate 4. This type of strengthening, combined with alloying of the solid solution, which guarantees a reduction in the diffusion mobility, is apparently the most effective method of improving the resistance of these γ alloys to gaseous swelling. (Metals Abstr.).

4057 EFFECT OF TEMPERING BETWEEN 300 AND 600°C ON THE STRUCTURE AND PROPERTIES OF A ZIRCONIUM–NIOBIUM 2.5% ALLOY. Tararaeva, E. M.; Alekseenko, G. K.; Utesheva, Z. A.; Ivanov, O. S. pp 162-169 of Stroenie i Svoistva Splavov dlya Atom. Energ. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Electrical resistance, superconductivity transition temperature, impact toughness, UTS, elongation, and reduction of area, and also electron microscopy and x-ray measurements were used to study the effect of tempering in the range 300–600°C of a Zr–Nb 2.5% alloy cold-deformed by 70% compression. At least two opposing processes occur at each temperature, i.e., recovery and ageing at 300–400°C; recrystallization ageing at 500–600°C. (Metals Abstr.).

4058 TOPOGRAPHICAL STRUCTURE OF GRAIN BOUNDARIES IN TUNGSTEN. Howell, P. R.; Ralph, B. (Cambridge Univ., Eng.). J. Microscopy; 102: No. 3, 361-369(Dec 1974).

This paper discusses the observation of a variety of topographical defects in grain boundaries in tungsten as a function of thermomechanical treatment. It is shown that, for both cold-worked and crept specimen material, the boundary topography is highly complex, whereas for secondary recrystallized specimen materials the boundaries approximate to that expected for an "equilibrium" configuration. However, no evidence for any period step structure was observed in this specimen material although, in this and all specimen states, grain boundary dislocations were frequently observed. (auth)

4059 UNIAXIAL STRAIN COMPRESSION OF POROUS AND FULLY DENSE BERYLLIUM. Beasley, D.; Turner, G. I.; Edwards, K. L. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Mater. Sci.; 10: No. 3, 436-442(Mar 1975).

Compressive stress versus uniaxial compressive strain curves obtained using a simple closed die are presented for SP-100-C beryllium of initial fractional porosities varying from 0.05 to 0.26, and for fully dense ingot beryllium. The relationship between porosity and compressive yield stress is found to be linear over the entire porosity range with a discontinuity at 0.065 fractional porosity. It is suggested that the discontinuity is related to the transition from isolated to predominantly interconnected porosity. It is deduced that the pressure required for full compaction varies with density and is estimated to range from 3.65×10^3 MN m^{-2} at 0.05 to 17.2×10^3 MN m^{-2} at 0.26 fractional porosity. (auth)

4060 INFLUENCE OF LAYER AND BOND STRENGTHS ON THE DUCTILITY OF AN ALL BERYLLIUM LAMINATE. Beasley, D.; Bunce, J. E. J. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Mater. Sci.; 10: No. 3, 443-452 (Mar 1975).

A limited study has been made of the effect of layer and bond strengths on the longitudinal tensile failure mode of an all beryllium laminate comprising a ductile (~5% elongation), high purity substrate and an adhering, brittle (<1%), layer. It is proposed that the overall ductility is related to the extent of delamination at the interface which, in turn, is determined by the ratio (R) of bond strength to layer strength. When R is 0.23, extensive delamination along the gauge length is obtained resulting in maximum ductility, but at R = 0.41 little separation occurs and the elongation is reduced almost to the minimum, namely that of the brittle layer. A simple calculation indicates that for the material used in this work, the influence on ductility of this mode of failure in the brittle condition may begin to be reduced when the layer is <⅓ of the total composite thickness, when multipoint delamination may be anticipated. (auth)

4061 VACANCIES AND SELF-INTERSTITIALS IN CADMIUM. Seeger, A.; Goesele, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Radiat. Eff.; 24: No. 2, 123-132(1975).

The temperature dependence of tracer self-diffusion measurements in cadmium is analyzed in conjunction with investigations of the equilibrium concentration of vacancies by thermal expansion and positron annihilation. The following values for the monovacancy migration enthalpies are obtained: $H^M_{IV,A} = 0.48$ eV for A-jumps (nearest-neighbor jumps in the basal plane), $H^M_{IV,B} = 0.40$ eV for B-jumps (nearest-neighbor jumps out of the basal plane). A nomenclature for the recovery stages of irradiated cadmium is proposed that is fully analogous to that for fcc metals. It is shown that Stage IV, for which an activation energy of (0.38 ± 0.03) eV has been measured, must be attributed to monovacancy migration, whereas Stage III, with activation energies varying between (0.23 ± 0.02) eV and (0.27 ± 0.03) eV, has to be assigned to the migration of self-interstitials. The spread in Stage-III activation energies and the unusual recovery kinetics may be understood in terms of a strong anisotropy in the diffusion coefficient of the self-interstitials. From this the configuration, the migration mode, and the activation energy of the Stage-III interstitial have been deduced. (auth)

4062 PERTURBATION THEORY AND THREE BODY FORCES IN HCP METALS. Bertoni, C. M.; Bisi, O.; Calandra, C.; Nizzoli, F. (Univ. of Modena, Italy). J. Phys., F (London); 5: No. 3, 419-434(Mar 1975).

An analysis is presented of the role of the nonpair forces in the lattice dynamics of sp bonded hcp metals: Be, Mg, and Li. By expanding the total energy up to third order in the electron-ion pseudopotential, a dynamical matrix is derived which contains terms arising from central pairwise interactions between the ions as well as contributions due to sums of three-body forces. The phonon dispersion relations are calculated using a local form of the model potential, which allows for a realistic evaluation of the third order contributions. Results show that the three-body forces are very important in Be and are responsible for the peculiarities

of the spectrum, as is most clearly seen from the analysis of the frequencies at the K point of the Brillouin zone. For Mg and Li, the inclusion of the unpaired forces does not change the results of the second-order theory appreciably, although it can be important in reproducing some details of the experimental data. The results are discussed by relating the importance of the third order to the details of the form factor and to the compensation between the ionic and electronic part of the dynamical matrix. A real space analysis of the theoretical results is also presented, from which information about the range of the three-body forces and the most important force constants can be obtained. (auth)

4063 PHOTOIONIZATION OF SAMARIUM IN THE THRESHOLD REGION. Parr, A.C. (Physics Department, The University of Alabama, University, Alabama 35486); Inghram, M.G. J. Opt. Soc. Am. 65: No. 5, 613-614 (May 1975).

We present photoionization-efficiency curves for samarium from below ionization onset to 1950 Å. (AIP)

4064 SIMULTANEOUS MEASUREMENTS OF SPECIFIC HEAT, ELECTRICAL RESISTIVITY, AND HEMISPHERICAL TOTAL EMITTANCE BY A PULSE HEATING TECHNIQUE: HAFNIUM-3 (WT PERCENT) ZIRCONIUM, 1500 to 2400°K. Cezairliyan, A.; McClure, J. L. (National Bureau of Standards, Washington, DC). J. Res. Natl. Bur. Stand., A.; 79A: No. 2, 431-436(1975).

Simultaneous measurements of specific heat, electrical resistivity and hemispherical total emittance of hafnium containing 3.12 wt percent zirconium in the temperature range 1500 to 2400°K by a subsecond-duration, pulse heating technique are described. The measurements indicate decreases in specific heat (by about 13 percent) and in electrical resistivity (by about 8 percent) as the result of the alpha yields beta transformation. Estimated inaccuracies of the measured properties are: 3 percent for specific heat, 1 percent for electrical resistivity, and 5 percent for hemispherical total emittance. (9 tables, 4 figures) (auth)

4065 ISOTHERMAL DOMAINS IN QUASI-ONE-DIMENSIONAL SUPERCONDUCTORS. Likharev, K.K. (Moscow State University). JETP Lett. 20: No. 11, 338-339 (5 Dec 1974).

It is shown that the usual generalization of the Ginzburg-Landau equations to conclude the nonstationary case leads directly to the possible existence of domain boundaries of the superconducting and normal phases in a homogeneous quasi-one-dimensional superconductor. The current that must flow through the conductor for such a boundary to be in equilibrium is somewhat smaller than the critical pair-breaking current. Thus, equilibrium between the current-induced domains in the superconductor can exist also without the thermal effect discussed by Volkov and Kogan. (auth)

4066 EFFECT OF LOW TEMPERATURE NEUTRON IRRADIATION ON SUPERCONDUCTING PROPERTIES OF Nb_3Sn. Soell, M. (Max-Planck-Institut fuer Plasmaphysik, Garching; Muenchen (F. R. Germany)). Bauer, H. (Giessen Univ. (F. R. Germany). Inst. fuer Angewandte Physik); Boening, K. (Muenchen, Univ. (F. R. Germany)); Bett, R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Phys. Lett., A; 51: No. 2, 83-84(10 Feb 1975).

Nb_3Sn diffusion wires were irradiated with fast neutrons at 4.6°K. Exposure to 3.9×10^{18} n/cm^2 caused an increase in the critical current density and a decrease in the transition temperature. (auth)

4067 STRUCTURAL CHANGES IN MOLYBDENUM AT A SHORT-TIME TENSILE TEST AND A HIGH TEMPERATURE CREEP. Zasimchuk, E. E.; Zelenyuk, E. E.; Marusii, O. I. (AN Ukrainskoi SSR, Kiev. Inst. Problem Prochnosti). Probl. Prochnosti; No. 5, 76-79(May 1974). (In Russian).

For English translation see the journal Strength Mater.

The results of x-radiographic and metallographic studies of the structure of commercial Mo with different initial structure, fracturing under conditions of short-term tensile stress and creep in a wide temperature interval, were reported. It was shown that during high-temperature tests the stress concentrators are the site of softening, which promotes accelerated deformation and fracture. (tr-auth)

4068 THE EFFECT OF A ZIRCONIUM STRENGTH DIFFERENTIAL ON CLADDING COLLAPSE PREDICTIONS. Lucas, G. E.; Bement, A. L. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). J. Nucl. Mater.; 55: No. 3, 246-252(Mar 1975).

An investigation was made into the occurrence of a strength differential in the Zircaloy cladding of LWR fuels, and into the effect such a strength differential can have on the analytical predictions of cladding creep collapse during fuel densification. The strength differential, or SD, refers to the difference in the compressive and tensile yield strengths of a material. It was concluded that an SD in Zircaloy cladding can have a significant effect on cladding collapse predictions; inclusion of SD considerations in cladding creep down analysis can increase predicted collapse times by a factor of two. (auth)

4069 STRAIN-AMPLITUDE-DEPENDENT INTERNAL FRICTION IN ANNEALED ZIRCONIUM-OXYGEN ALLOYS. Atrens, A. (Melbourne Univ., Parkville (Australia). Dept. of Metallurgy). J. Nucl. Mater.; 55: No. 3, 267-272(Mar 1975).

For annealed zirconium alloys the damping was critically prestrain dependent: a prestrain of 2.0×10^{-4} changed the logarithmic decrement from being purely amplitude independent to being amplitude independent only up to a critical strain amplitude, whereupon the logarithmic decrement increased with strain amplitude to a maximum value and then decreased. The logarithmic decrement-strain amplitude peak height increased with increasing number of cycles at a strain amplitude of 3.0×10^{-4}, owing to a dislocation density increase. Increasing the prestrain caused a similar dislocation density increase. (auth)

4070 A RESISTOMETRIC STUDY OF AGEING IN NIMONIC ALLOYS. II. 80A. White, R. J.; Swallow, G. A.; Fisher, S. B.; Miller, K. M. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). J. Nucl. Mater.; 55: No. 3, 273-278(Mar 1975).

The resistance changes observed on the isothermal ageing of solution-treated Nimonic 80A are discussed. Ageings were carried out in the temperature range 800 to 1040 K. The nucleation of γ' is initially controlled by the supersaturation of quenched-in vacancies; this transient rapidly decays to leave precipitation controlled by thermally activated vacancies. The activation energy of the initial ageing rate, of 1.10 ± 0.10 eV, is associated with the migration of Al and Ti onto Ni-rich regions and possibly with a relaxation process on nucleation. The time for the resistance change to reach a maximum is strongly temperature-dependent in 80A. The activation energy for this process, 2.9 ± 0.3 eV, agrees with the accepted values for the isothermal diffusion activation energy. (auth)

4071 HYDROGEN TRANSPORT IN MOLYBDENUM. Caskey, G. R. Jr.; Louthan, M. R. Jr.; Derrick, R. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). J. Nucl. Mater.; 55: No. 3, 279-283(Mar 1975).

The permeability of cold-rolled molybdenum to deuterium at about 1 atm pressure for the temperature range of 523 to 730 K is given by the relation $\phi = 3.22 \times 10^{-4} \exp [-19828 \text{ cal} \cdot \text{mol}^{-1}/RT]$ in general agreement with earlier studies of hydrogen permeation. Evidence of reversible trapping of hydrogen at internal defects is found in autoradiographs of tritium-charged molybdenum wires, which show inhomogeneous darkening, and in the transient permeation and evolution rates of deuterium from molybdenum foils. (auth)

4072 KINETICS AND MECHANISM OF THE REACTION OF β-ZIRCONIUM WITH OXYGEN AT LOW PRESSURES. Hoerz, G.; Hammel, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart (F. R. Germany). Inst. fuer Werkstoffwissenschaften). J. Nucl. Mater.; 55: No. 3, 284-290(Mar 1975).

The kinetics and mechanism of the reaction of β-zirconium with oxygen to form solid solutions with oxygen at temperatures between 1100 and 1600°C and at pressures between 1×10^{-5} and 8×10^{-4} torr were investigated by measuring the electrical resistivity of the specimens (wires with 0.5 mm diameter) continuously during the reaction. It was found that the rate of oxygen dissolution is independent of reaction time and oxygen already dissolved, is proportional to the oxygen pressure, and depends only slightly on temperature. The reaction coefficient increases from 0.67 at 1100°C to 0.75 at 1600°C. The rate of oxygen dissolution is essentially determined by the transport of the oxygen to the metal surface. (auth)

4073 ELECTRICAL RESISTIVITY OF β-ZIRCONIUM-OXYGEN SOLID SOLUTIONS AS A FUNCTION OF OXYGEN CONCENTRATION AND TEMPERATURE. Hoerz, G.; Hammel, M.; Kanbach, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart (F. R. Germany). Inst. fuer Werkstoffwissenschaften). J. Nucl. Mater.; 55: No. 3, 291-298(Mar 1975).

The electrical resistivity of recrystallized, pure β-zirconium at temperatures between 900 and 1700°C as well as the resistivity of β-zirconium-oxygen solid solutions at temperatures between 1100 and 1700°C were measured. It was found that the resistivity increases linearly with temperature at a constant oxygen concentration and increases linearly with the oxygen concentration at a constant temperature. The supplementary resistivity $\Delta\rho/\Delta f$ caused by the dissolution of oxygen decreases linearly with in-

creasing temperature, i.e. Matthiessen's rule is not obeyed. The temperature (T) and oxygen concentration (f) dependence of the electrical resistivity ρ of β-zirconium-oxygen solid solutions at temperatures between 1100 and 1700°C can be represented by the relation $\rho = 91.9 + 2.30 \times 10^{-2}T + 10^{2}f(3.75 - 1.03 \times 10^{-3}T)$ with ρ in $\mu\Omega$. cm, f in atomic ratio n_O/n_{Zr} and T in °C. Taking these results and literature data into consideration, a survey of the electrical resistivity of zirconium-oxygen solid solutions, including the α-range, is given. (auth)

4074 ELASTIC CONSTANTS OF ZIRCONIUM ALLOYS. Northwood, D. O.; London, I. M.; Bahen, L. E. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). J. Nucl. Mater.; 55: No. 3, 299-310(Mar 1975).

The dynamic elastic moduli of Zircaloy-2, Zr–1.15 wt% Cr–0.1 wt% Fe, and Zr–2.5 wt% Nb were determined over the temperature range 293 to 773 K. Young's modulus and shear modulus decreased linearly with increasing temperature. Poisson's ratio decreased with increasing temperature for Zircaloy-2 and Zr–2.5 wt% Nb but increased for Zr–1.15 wt% Cr–0.1 wt% Fe. The results were compared with previous values determined both by static and dynamic techniques and with polycrystalline constants computed from single crystal elastic constants. The difference in behaviour between the three alloys is not due to differences in alloy composition but to texture effects. A relationship is derived between texture and elastic constants. (auth)

4075 STUDY OF SOLID SOLUTION DECOMPOSITION IN WELDED JOINTS OF NIOBIUM ALLOYS BY THE ELECTRIC RESISTANCE METHOD. Aref'ev, Yu. V.; Chernyshova, T. A.; Shorshorov, M. Kh. Svar. Proizv.; No. 7, 8-9(Jul 1974). (In Russian).

For English translation see the journal Weld. Prod.

A study was made of the kinetics of solid solution breakdown in the fused zones of welded niobium alloy by the electrical resistance method. Graphs are presented of the change in electrical resistance of the sample during annealing. The change in electrical resistance is complex in character, and is associated with the separation of a number of phases. The activation energy was determined for the decomposition of alloys having varying contents of carbon. It is shown that satisfactory, stable plastic properties of niobium weld alloys containing up to 0.1% carbon can be obtained only after prolonged, high-temperature thermal treatment (1200 to 1300°C, 2 hours). (tr-SJR)

4076 INVESTIGATION INTO THE PROPERTIES OF MAGNESIUM–GADOLINIUM ALLOYS. Drits, M. E.; Sviderskaya, Z. A.; Nikitina, N. I. Tekhnol. Legk. Splavov.; No. 5, 12-17(1974). (In Russian).

A study was made of the effect of gadolinium on the mechanical properties of magnesium at room and higher (250, 300, and 350°C) temperatures, and the possibility of strengthening Mg–Gd alloys by thermal treatment was also investigated. The introduction of up to 8% Gd into magnesium leads to an increase in strength properties of the magnesium and also in the short-term hardness at all test temperatures. (tr-SJR)

4077 STRUCTURE OF FRACTURE FOLLOWING PLASTIC DESTRUCTION OF WELDED JOINT OF TsM6 MOLYBDENUM ALLOY. Kantor, M. M.; Morgunova, N. N.; Ignatov, D. V.; Guseva, E. A.; Voronov, N. I.; Pod yapol'skii, G. V. (An SSSR, Moscow. Inst. Metallurgii). Svar. Proizv.; No. 7, 12-13(Jul 1974). (In Russian).

For English translation see the journal Weld. Prod.

By electron microscopy a study was made of the structure of fractures in samples of weld molybdenum alloy TsM6 which was tested under bending. The formation of a cup-shaped fracture relief in the alloy was established and explained as being characteristic of brittle metal fracture. The presence of sections with a grooved and step-like relief on the fracture surface is also characteristic of brittle metal fracture. (tr-SJR)

4078 AN X-RAY INVESTIGATION OF ORDERING IN TERNARY ^{75}Mg AT. %–Cd–In ALLOYS. Shastry, C. R.; Bhan, S. (Banaras Hindu Univ. (India). Dept. of Metallurgical Engineering). Z. Metallk.; 66: No. 1, 56-58(Jan 1975).

1 fig.; 1 tab.; 7 refs.

X-ray analysis of Mg_3Cd–Mg_3In sub-system shows that the solid solubility of Mg_3Cd extends up to $Mg_{75}Cd_9In_{16}$ at 400°C in disordered state and to $Mg_{75}Cd_{8.5}In_{16.5}$ at 100°C in ordered state. The hardness measurement and lattice parameters are reported in disordered as well as ordered alloys. (auth)

4079 REFINED STEELS FOR REACTOR TECHNOLOGY. Bitter, H. G. (Deutsche Edelstahlwerke A. G., Krefeld (F. R. Germany)). Kerntechnik; 16: No. 12, 543-544(Dec 1974). (In German).

3 figs.; 2 tabs.

Proved special steels have to undergo specific metallurgical and ductility treatments as well as highly sophisticated tests, if they are to be used in reactor engineering. Details depend on the kind of component to be constructed. A number of examples are given, and data of special steels used in reactor engineering are summarized in a table. (auth)

4080 ISOTOPIC EFFECT IN THE ORDERING TEMPERATURE OF HYDROGEN IN METALS. Entin, I. R.; Somenkov, V. A.; Shil'shtein, S. Sh. Sov. Phys.-Solid State (Engl. Transl.); 16: No. 8, 1569-1571(Feb 1975).

Translated from Fiz. Tverd. Tela; 16: No. 8, 2412-2415(Aug 1974).

The unusual features of the atomic dynamics of solid solutions of hydrogen in metals [the high (~1000°K) local-vibration energies and the possibility of causing a sharp change in the mass of the impurity atoms by replacing hydrogen by deuterium] make these systems convenient for studying the effects of vibrations on the ordering process. For example, an isotopic effect has been observed experimentally in the ordering temperatures of hydrogen atoms in group V metals (V, Nb, and Ta); in all cases except that of $V_2H(D)$ the ordering temperature of the hydrogen solution has been found to be several percent lower than that for an isomorphic deuterium solution. In $V_2H(D)$ the effect has the opposite sign and is larger. These effects are analyzed. Results show that in solid solutions of hydrogen in metals the vibrations of the interior atoms strongly influence the temperature of the order-disorder phase transition. The possibility that this circumstance should also be taken into account in the case of other transitions accompanied by a redistribution of light atoms is not ruled out. (auth)

4081 INTERBAND OPTICAL ABSORPTION AND THE ELECTRONIC STRUCTURE OF 5d METALS. Kirillova, M. M.; Nomerovannaya, L. V.; Noskov, M. M. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 16: No. 8, 1425-1429(Feb 1975).

Translated from Fiz. Tverd. Tela; 16: No. 8, 2181-2187(Aug 1974).

The refractive index n and the absorption coefficient k of the (110) face of a Ta single crystal were measured by a polarometric method over the range 0.3 to 17 μ ($\hbar\omega$ = 4.09 to 0.072 eV). The optical conductivity $\sigma(\omega)$ and permittivity $\epsilon_1(\omega)$ were calculated from the values of n and k. The optical properties of tantalum and the other 5d metals (W, Re, Ir and Pt) are discussed together, and the intra- and interband contributions to the conductivity $\sigma(\omega)$ are separated. For the 5d metals the onset of interband transitions occurs for energies ~0.1 to 0.3 eV, and they take place continuously over the whole of the observed spectral range up to 5 eV and beyond. The detailed structure and the overall shape of the interband absorption curves for Ta, W, Re, Ir, and Pt are compared with one-electron band calculations. It is shown that the anomalies in $\sigma_{inter}(\omega)$ at low energies are associated with the spin-orbit splitting of the bands. It is pointed out that the electron density of states N(E) plays the dominant role in the interband optical absorption. (auth)

4082 DISPERSION OF PHONON WAVES IN PLATINUM AND THORIUM. Cavalheiro, R.; Shukla, M. M. (Universidade Estadual de Campinas, Brazil). Nuovo Cim.; 26B: No. 1, 220-228 (11 Mar 1975).

The extended de Launay's model has been used to study the lattice dynamics of platinum and thorium. Calculated phonon dispersion curves along the principal symmetry directions and (θ-T)-curves of them have been found to show reasonable agreement with the experimental results. (auth)

4083 INFLUENCE OF CONSTRAINT, HEAT TREATMENTS AND COUPLINGS ON THE INTERGRANULAR CRACKING OF THE ALLOYS INCONEL 600 AND X 750. Blanchet, J.; Coriou, H.; Grall, L.; Mahieu, C.; Otter, C.; Turluer, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service d'Etude de la Corrosion et d'Electrochimie). J. Nucl. Mater.; 55: No. 2, 187-206(Feb 1975). (In French).

Past work on the stress-corrosion cracking of alloys of the Inconel 600 type in high-temperature water is surveyed. The influence of the following variables was studied: stress, heat-treatment, joining, grain size, and structure. A hypothesis, based on the presence of sulphur compounds in the alloy, is advanced to account for the mechanism of cracking. (auth)

Radiation Effects

Refer also to abstracts 3433, 4495, 5207, and 5568.

4084 (AD/A-002731) STRENGTH AND NOTCH DUCTILITY OF SELECTED STRUCTURAL ALLOYS AFTER HIGH-FLUENCE, 550 F (288 C) IRRADIATION. Hawthorne, J. R.; Watson, H. E.

(Naval Research Lab., Washington, D. C. (USA)). 2 Dec 1974. Contract AT(49-5)-2110. 25p. NTIS $3.25.

Tensile strength and charpy-v (c sub v) notch ductility changes with 550°F irradiation were explored for several low alloy structural steels. The study was addressed to metal fracture resistance at upper shelf temperatures and encompassed A302-B, A533-B, A543-1, 9Ni-4Co-.20C, 12-6PH, and 12Ni-5Cr-3Mo steel compositions. Material forms included plate, forging, and weld deposit. Specimen irradiations were conducted in the advanced test reactor (ATR); neutron fluences ranged from 1 to 7×10^{20} n/cm^2 1 MeV. The implications to postirradiation fracture resistance of c sub v upper-shelf values were assessed using NRL-developed ratio analysis diagram (RAD) procedures. RAD assessments of a low-copper content A533-B plate and weld deposit indicated that thick sections of either material would exhibit plastic fracture behavior after 2.5×10^{20} n/cm^2 > 1 MeV at 550°F. An experimental 12-6PH alloy of higher strength is also shown to have promise for high-fluence applications. (GRA)

4085 (AED-CONF-74-516-002) FLUX PINNING IN NEUTRON IRRADIATED NIOBIUM. I. Magnetic Behavior in Stationary Fields. II. Magnetic Behavior in Alternating Fields. van der Klein, C. A. M.; Kes, P. H.; de Klerk, D. (Rijksuniversiteit Leiden (Netherlands). Kamerlingh Onnes Lab.). 1974. 13p. INIS.

From international discussion meeting on flux pinning in superconductors; St. Andreasberg, F. R. Germany (23 Sep 1974).

The effect of neutron irradiation on the flux pinning in chemically very pure niobium was investigated. The increase of H_{C_2}, the irreversibility of the magnetization curve, and the peak effect, are presented. (GE)

4086 (AED-CONF-74-516-005) FLUX PINNING IN NEUTRON IRRADIATED NIOBIUM. Magnetic Behavior in Alternating Fields. Kes, P. H.; van der Klein, C. A. M.; de Klerk, D. (Rijksuniversiteit Leiden (Netherlands). Kamerlingh Onnes Lab.). 1974. 6p. INIS.

From international discussion meeting on flux pinning in superconductors; St. Andreasberg, F. R. Germany (23 Sep 1974).

The effect of neutron irradiation on the flux pinning behavior of niobium in stationary fields is considered and the pinning properties of the same (oxidized) samples of Nb is discussed when a small, paraliel, sinusoidal field H_0 cos wt is superimposed on the dc field. (GE)

4087 (AED-CONF-74-587-047) RADIATION EFFECTS ON MECHANICAL PROPERTIES AND MICROSTRUCTURE OF SOLUTION-TREATED AND COLD-WORKED 1X18H10T AND 0X16H15M3B STAINLESS STEELS. Vorobyev, A. N.; Bykov, V. N.; Dmitriev, V. D.; Shcherbak, V. I. (Institute of Physics and Power Engineering, Obninsk, USSR). 1974. 21p. INIS.

From European conference on irradiation behavior of fuel cladding and core component materials; Karlsruhe, F. R. Germany (3 Dec 1974).

8 figs.; 1 tab.; 13 refs. With abstract.

This paper includes experimental studies of the radiation effects on the mechanical properties, microstructure and swelling of the 1X18H10T and 0X16H15M3B stainless steels as a function of cold work and thermo-mechanical treatment (TMT). (auth)

4088 (KFK-1996) LOW-TEMPERATURE IRRADIATION MEASUREMENTS OF A V_3Ga MULTIFILAMENTARY COMPOSITE WIRE. Krebs, K. R.; Maier, P.; Seibt, E. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Dec 1974. 52p. (In German). INIS.

Angular dependent critical current measurements of a V_3Ga multifilamentary composite wire (360 filaments) were performed in the helium bath irradiation facility of the Karlsruhe cyclotron for determination of the critical current and the volume pinning forces. For the critical current I_{co} and increase was observed at a position parallel to the external magnet field ($\theta = 0°$) relative to a transversal position ($\theta = 90°$). An anisotropy was found for $I_{co}(0°)/I_{co}(90°) = 1.45 \pm 0.05$ between B = 3 and 7 T. The V_3Ga wire was irradiated with 50 MeV deuterons at a sample temperature of less than 15 K up to a total maximum flux of 2.6×10^{17} cm^{-2}. In the experiment, a reduction of about 16% and 50% was observed in the transition temperature and in the critical current, respectively. In subsequent annealing experiments conducted at room temperature (21°C) and at 100°C only a small recovery of about 15% at the maximum was obtained for the critical current. Some estimations are reported of the number of atomic displacements and defect cluster widths in sample material. The field dependence of the volume pinning force before and after irradiation is compared to theoretical models. (auth)

4089 (RD/B/N-3170) VOID SWELLING IN HIGHLY IRRADIATED STAINLESS STEEL TYPE 304. Buswell, J. T. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Oct 1974. 9p. Dep. NTIS (US Sales Only) $4.00.

Specimens of solution treated type 304 stainless steel were electron irradiated in a high voltage electron microscope to doses in the range 70 to 100 dpa at 510 and 560°C. Similar values of volume swelling, V/V_0 at a given dose, were obtained with differing values of the void number density, N(v). The volume swelling was approximately 20% at 70 dpa, with $N(V) = 1.7 \times 10^{21}$ m^{-3} at 510°C and $N(V) = 5.1 \times 10^{20}$ m^{-3} at 560°C. There was no evidence of a saturation in the swelling. It was concluded that the engineering consequences of a saturation in swelling at a dose greater than 100 dpa would be neither beneficial nor detrimental. (auth)

4090 (TID/SNA-2072) S-110 RADIATION EFFECTS ANALYSIS OF STRUCTURAL SUPPORT BLOCK VALVE, EC 90261. French, W. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 5 Jan 1971. 86p. Dep. NTIS $7.50.

An analysis of the availability of data for candidate structure support block valve (SSBV) materials (aluminum 6061-T6, stainless steel 440C, stainless steel 347, phosphor bronze, stainless steel 321 and stainless steel A-286) with respect to the anticipated nuclear environment and the properties required for design was completed. Previous reactor tests have supplied information on tensile properties within the general fluence/temperature range of the NERVA requirements for the SSBV candidate materials except for phosphor bronze and 321 stainless steel. The tests were small in scope and served to provide answers for particular situations. None of the tests provide sufficient experience (reliability and confidence level) comparable to the properties and fluences dictated by the presently specified NERVA engine useful life which is 10 hours. Aluminum 6061-T6 and stainless steels 347 and A-286 exhibit increased tensile strength and decreased ductility at SSBV fluences and temperatures. Hence, these materials should remain ductile under SSBV usage. No further material characterization tests are required. Stainless steel 321 is expected to exhibit the same characteristics (increased tensile strength and decreased ductility) as 347 stainless steel. However, because of the critical use of this component (bellows seal) and lack of data, a tensile screening test should be performed. Irradiation damage of phosphor bronze which is a candidate material for the valve seal is not known. A tensile screening test, REIR #632, was prepared. (auth)

4091 (TID/SNA-2107) EFFECT OF CRYOGENIC IRRADIATION ON NERVA STRUCTURAL ALLOYS. Dixon, C. E.; Davidson, M. J.; Funk, C. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1 Mar 1971. 8p. Dep. NTIS $4.00.

Hastelloy X, AISI 347, A-286 bolts, Inconel 718, Al 7039-T63, and Ti-5Al-2.5Sn ELI were irradiated in liquid nitrogen (140°R) to neutron fluences between 10^{17} and 10^{19} nvt (E > 1.0 MeV). After irradiation, tensile properties were obtained in liquid nitrogen without permitting any warmup except for some specimens which were annealed at 540°R. The usual trend of radiation damage typical for materials irradiated at and above room temperature was observed, e.g., increase in strength and decrease in ductility. However, the damage at 140°R was greater because this temperature prevented the annealing of radiation-induced defects which occurs above 140°R. Results show that the threshold for measurable mechanical property damage in these materials at 140°R is between 10^{16} and 10^{17} nvt (E > 1.0 MeV). Room temperature annealing of tensile properties was performed prior to testing some of the alloys. Al 7039-T63 recovers about half the damage incurred at the highest exposure while the other alloys recover a smaller amount. Previous similar studies of Al 2219 showed almost complete recovery after annealing at room temperature. Aluminum components in the NERVA engine will be at temperatures above 140°R during its coast periods. Additional postradiation annealing studies are required to establish design properties after thermal cycling to various temperatures. (auth)

4092 (WANL-TME-705) IRRADIATION EFFECTS ON TIE ROD MATERIALS. Thornton, J. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 28 Feb 1964. 45p. Dep. NTIS $5.25.

Declassified 12 Sep 1973.

Tensile and notched tensile properties of four materials were studied for changes as a result of cryogenic irradiation and postirradiation annealing effects. The program consisted of a total of 280 forged and machined specimens of Inconel X-750, Inconel 718, Hastelloy R-235, and A-286. The Inconel X-750 is the NRX-A tie rod material and is a face-centered cubic, nickel-base, precipitation hardened alloy. The Inconel 718 and Hastelloy R-235 are in

the same alloy class as Inconel X-750, while A-286 is an iron base alloy. The irradiation was carried out in liquid nitrogen (−320°F) at the Ground Test Reactor (GTR) of the Nuclear Aerospace Research Facility (NARF) at General Dynamics in Fort Worth, Texas (GD/FW). The dose received by the samples was between 2.4 and 7.1×10^{16} n/cm^2 (E > 1 MeV), which is low compared to 3×10^{17} n/cm^2 (E > 1 MeV) for a five-minute full power operation at the thread end of a centerline tie rod. Slight but significant changes in properties were noted for all materials. Generally, strength increased without loss in ductility for samples tested in situ immediately after irradiation. After storage at room temperature and testing at −320°F, decreases in ductility for Inconel X-750 and Inconel 718 were observed. These decreases in ductility were accompanied by decreases in ultimate strength and increases in yield strength. The original properties of Inconel 718 and Inconel X-750 were recovered after the 1000°F annealing treatment. The reliability of tie rods would not be reduced by the observed changes caused by equivalent dosage, but the damage mechanism is important and probably applies to all alloys in the class. It is suggested that immediately after irradiation the damage in the material consists of a large number of widely scattered point defects consisting of vacancy-interstitial pairs, which inhibit motion of dislocations but do not contribute to nucleation of cracks. This would explain increases in strength without great losses in ductility. After room temperature annealing, the defects have partially clustered and become large enough to pin dislocations causing them to pile up and act as crack nuclei. The observed increases in yield strength and decreases in ultimate strength and ductility can thus be explained. The recovery of original properties after 1000°F annealing is suggested as being due to the dispersal of the clusters by the uniting of vacancies and interstitials and/or by the diffusion of the two to grain boundaries, sub grain boundaries or other sinks. Slight property changes in the Hastelloy R-235 were also noted, even though these samples received less than half of the dose of the Inconel X-750 and Inconel 718. It is concluded that all materials had adequate properties after irradiation, and after irradiation plus annealing. However, trends were indicated which could change this conclusion for higher dose levels and/or annealing at a wider variety of temperatures and times. (auth)

4093 COOPERATIVE GROWTH OF DISLOCATION LOOPS AND VOIDS UNDER ELECTRON IRRADIATION. Kenik, E.; Mitchell, T. E. (Case Western Reserve Univ., Cleveland). Radiat. Eff.; 24: No. 3, 155-160(1975).

Electron irradiation damage studies have been performed on thin foils of pure copper in a high voltage electron microscope. The effects of foil thickness, electron flux, temperature, and initial dislocation density on the formation of voids were studied. Kinetics of void nucleation and growth were interpreted in terms of dislocation biasing of the vacancy and interstitial concentrations and the capture ratio. The void density initially increased as a function of dislocation density, while void size decreased. As a result, swelling at first was increased and subsequently decreased with increasing dislocation density. It was thus confirmed that the presence of dislocations is a necessary condition for void formation. (auth)

4094 DISTRIBUTION OF RECOIL MOMENTA IN A COLLISION CASCADE. Sanders, J. B.; Roosendaal, H. E. (Stichting voor Fundamental Onderzoek der Materie, Amsterdam). Radiat. Eff.; 24: No. 3, 161-172(1975).

For a collision cascade, initiated by a high-energy (order of 100 keV) projectile the average number of recoil particles is calculated which receive a specified kinetic energy and a specified direction of motion, relative to the initial direction of motion of the projectile. Characteristic for this expression is the fact that a δ-function connecting these two parameters occurs in it. (auth)

4095 RECOVERY OF NEUTRON IRRADIATED VANADIUM. Pande, B. M.; Anand, M. S.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 24: No. 3, 173-175 (1975).

The recovery of partially and well annealed vanadium irradiated to a fast neutron fluence of 1×10^{18} n/cm^2 was carried out above room temperature. The recovery stage at 170°C has been attributed to the intrinsic point defects. The difference in the reaction order between the well and partially annealed samples arises due to the nature of sinks. (auth)

4096 IRRADIATION CREEP IN SOME AUSTENITIC STAINLESS STEELS, NIMONIC PE16 ALLOY, AND NICKEL. Mosedale, D.; Lewthwaite, G. W. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). pp 169-188 of Creep Strength in Steel and High-Temperature Alloys. London; Metals Society (1974).

From meeting on creep strength in steel and high-temperature alloys; Sheffield, Eng. (20 Sep 1972).

Helical springs, made from austenitic stainless steels, from Nimonic PE 16 alloy, and from nickel, were loaded in tension and irradiated (in sodium at about 280°C) in the Dounreay fast reactor to total neutron fluences up to a maximum of 1.7×10^{26} m^{-2}. In-reactor times ranged up to about 4500 h. Similar springs were stressed in the laboratory (at 300°C in air) and, in the case of some compositions, in sodium; all show creep of rapidly diminishing rate. The reactor springs for which deflection changes were assessed from X-radiographs of the irradiation vehicles during reactor shutdowns, creep more than the laboratory controls. In the steels, typically, irradiation creep diminishes rapidly to a steady state, linearly dependent on displacement damage. Nimonic PE 16 also suffers primary creep, but it is not yet clear if there is a continuing irradiation effect. Nickel creeps most, but not dramatically more than the weakest of the stainless steels. Cold-worked steel springs show significantly more primary creep than solution treated specimens of the same composition and batch, and there are differences between steels with different specifications and between batches of one steel. Where data suffice for an assessment, both primary and secondary creep exhibit linear dependences on stress. Thermal creep data, available for one batch of AISI 316 steel at 500°C, and for another at 600 to 650°C, are compared with irradiation creep data for these steels. The experimental results are discussed in the context of existing theory. (auth)

4097 EFFECT OF FAST ELECTRON IRRADIATION ON THE MECHANISM OF DISPERSION OF CARRIERS IN GERMANIUM STUDIED BY CYCLOTRON RESONANCE. Sirota, N. N.; Lukasheva, V. I.; Kurochkin, L. A. (Inst. of Physics of Solid State Semi-conductors, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 121-123(1975). (In Russian).

Cyclotron resonance in the temperature interval 1.8 to 4.2°K was used to isolate the contribution to the mechanism of dispersion of carriers, related to dispersion on radiation defects introduced into germanium by irradiation with fast electrons. (tr-auth)

4098 EFFECT OF PROTON IRRADIATION ON THE MECHANICAL PROPERTIES OF ALUMINUM. Maiorov, S. V.; Ivanov, L. I.; Bondarenko, G. G.; Makhlin, N. A. Fiz. Khim. Obrab. Mater.; No. 1, 159-160(1975). (In Russian).

Samples of polycrystalline aluminum (99.99%) 13 and 25 microns thick were subjected to irradiation by 140-keV protons in the dose interval of 1×10^{16} to 1×10^{17} protons/cm^2. A study was carried out of the change in mechanical characteristics (elongation and tensile strength). It was established that the plasticity of the samples decreased by 50% at a dose of 1×10^{17} protons/cm^2. It is shown that the accumulation of radiation defects of the type of bubbles and dislocation loops is responsible for the observed strengthening. (tr-auth)

4099 FREE MIGRATION OF INTERSTITIALS IN TUNGSTEN. Okuda, S.; Mizubayashi, H. (Japan Atomic Energy Research Institute, Tokai-Mura, Ibaraki, Japan). Phys. Rev. Lett. 34: No. 13, 815-817 (31 Mar 1975).

The internal friction and dynamic modulus of W single crystals were measured after neutron irradiation near liquid-helium temperature. The results on dislocation pinning and the associated relaxation peaks suggest that in W the ⟨110⟩ split interstitials perform a free migration at ≈15 K (substage I_1) and the ≈30-K stage (substage I_2) is associated with detrapping of the ⟨110⟩ split interstitials from impurity atoms. (auth)

4100 INFLUENCE OF MAGNESIUM ADDITIONS ON THE LOW TEMPERATURE RECOVERY STAGES IN NEUTRON IRRADIATED ALUMINIUM. Dimitrov, C.; Moreau, F.; Dimitrov, O. (CNRS, Vitry-sur-Seine, France). J. Phys., F (London); 5: No. 3, 385-399(Mar 1975).

In order to investigate the interaction between interstitial defects and impurity atoms in aluminium, a series of dilute Al–Mg alloys were neutron irradiated at 24°K. The recovery of electrical resistivity shows that the addition of increasing magnesium concentrations decreases the high temperature part (32 to 55°K) of stage I. This decrease should be associated with the trapping of mobile interstitials by foreign atoms. The sub-stages detected by differences in the effect of the addition element are attributed, successively, to close pair recombination, and to the annihilation of interstitials with vacancies respectively inside and outside the zones, resulting from displacement cascades. The migration energy of a free interstitial has been found equal to 125 ± 5 MeV. Stage II (55 to 175°K) is also modified by magnesium additions but two opposite effects are observed according to the temperature range. Below 100°K, sub-stage II_A has a behavior similar to that of stage I; its amplitude decreases with increasing magnesium content. This sub-stage appears to be the result of several recovery mechanisms which involve

multiple interstitial defects. Inversely, above 100°K, stage II_B, which does not exist in pure aluminium, appears and grows in importance for higher concentrations. As suggested previously for samples irradiated at 78°K, it is attributed to the dissociation of interstitial-impurity complexes. (auth)

4101 INTERSTITIAL TRAPPING AND DETRAPPING IN ELECTRON IRRADIATED DILUTE COPPER ALLOYS. Dworschak, F.; Lennartz, R.; Wollenberger, H. (Van de Graaff-Labor, Aache). J. Phys., F (London); 5: No. 3, 400-418(Mar 1975).

The interaction of migrating copper interstitials with impurities was investigated by damage rate measurements in dilute copper alloys with Au, Be, Ge, Ni, Pd, Sb, Zn at irradiation temperatures between 50 and 170°K. By applying the diffusion theory of the three dimensionally migrating interstitials to the data, the resistivity contribution of trapped interstitials and the capture radii of impurities of migrating interstitials have been determined. The above mentioned resistivity contribution was found to be independent of the impurity species and of irradiation temperature. The capture radii of all impurities decrease with increasing irradiation temperature and become zero at about 110°K except that of Be. From the coincidence of this temperature with that of a recovery stage, it is concluded that this recovery stage is caused by detrapping of interstitials. The continuous decrease of the capture radii with increasing temperature starting already from 50°K is explained by radiation induced detrapping. The cross section of a trapped interstitial to become detrapped is about 10^6 barn. (auth)

4102 LOW DOSE PRODUCTION STUDIES OF PLATINUM AT IRRADIATION TEMPERATURE OF 140°K. Ryan, E. A. (Argonne National Lab., IL); Jackson, J. J.; Lwin, Y. N. Radiat. Eff.; 23: No. 4, 279-280(1974).

Reference is made to a model proposed by Brugiere and Lucasson (Rad. Effects 11: 55(1971)) to explain radiation effects data for Al and Pt on quenching and annealing. This model is based on the premise that vacancies cluster around impurity atoms during quenching. Simple calculations based on this model were made and substantial inconsistencies were found. Experimental investigations were also made and it was found that the model does not fit the data. (UK)

4103 COMMENT ON "A CRITIQUE OF THE UNSATURABLE TRAP MODEL OF RADIATION DAMAGE IN METALS." Dworschak, F. (Kernforschungsanlage, Juelich GmbH, Ger.); Wollenberger, H. Radiat. Eff.; 24: No. 2, 141-142(1975).

Reference is made to a publication by Frank et al., (Rad. Effects, to be published) to be entitled "a critique of the unsaturable trap model of radiation damage in metals," which it is said will assign a number of statements to the present authors and their associates which do not agree with the interpretation of irradiation damage experiments in the Stage II region as presented by the present authors in their various publications. These statements are quoted and discussed. (UK)

4104 FIELD ION MICROSCOPE OBSERVATIONS OF VOIDS IN NEUTRON IRRADIATED MOLYBDENUM. Brenner, S. S. (United States Steel Corp., Monroeville, PA); Seidman, D. N. Radiat. Eff.; 24: No. 2, 73-78(1975).

The voids forming a three-dimensional lattice in a molybdenum specimen irradiated at 550°C to a fast neutron fluence of approximately 1×10^{22} n cm^{-2} were investigated by the field ion microscope (FIM) technique. Numerical values obtained for the mean void diameter, number density, and mean spacing are in approximate agreement with transmission electron microscope observations. Controlled field evaporation sequences through sixteen voids revealed complex atomic displacements around each void, much of which is a result of the void intersecting the surface. The advantages of the FIM technique for the study of high number densities ($\geq 5 \times 10^{17}$ cm^{-3}) of voids are discussed and the potentialities of the FIM atom probe for the solution of problems concerning the nucleation and stabilization of voids is also considered. (auth)

4105 PRODUCTION AND ANNEALING STUDIES OF LEAD IRRADIATED WITH PROTONS OR DEUTERONS. Ryan, E. A. (Argonne National Lab., IL); Jackson, J. J.; Lwin, Y. N.; Emerson, D. L. Radiat. Eff.; 24: No. 2, 89-94(1975).

In contrast to existing high-dose electron irradiation data, approximately 50% recovery occurs below 70°K in pure lead ($R_{273K}/R_{4.2K} > 10{,}000$) irradiated at 7.3°K with either 11-MeV protons or 22-MeV deuterons with doses up to 33×10^{-9} Ω cm. Recovery decreased with increasing dose for doses between 5.8 and 33×10^{-9} Ω cm and was increased by pre-irradiation and partial annealing. Previous identification of stage I_D as that occurring at 170°K appears in error in view of the results. Furthermore annealing data after neutron irradiation and plastic deformation data are substantially in agreement with the present interpretation. (auth)

4106 POSITION ANNIHILATION IN NEUTRON-IRRADIATED p-TYPE Ge. Yeh, C. K. (Inst. of Nuclear Energy Research, Tao-Yuan, Taiwan); Meng, H. C.; Lee, Y. H.; Cheng, L. J. Radiat. Eff.; 24: No. 2, 95-100(1975).

Effects of neutron irradiation and subsequent thermal annealings on positron annihilation rates in p-type germanium were studied. Two annihilation rates ($4.17 \pm 0.08 \times 10^9$ s^{-1} with an intensity of 98% and $7.1 \pm 1.0 \times 10^9$ s^{-1} with an intensity of 2%) are observed in unirradiated samples. Only the annihilation rate of the dominant component becomes smaller upon irradiation, showing that some neutron-induced defects in Ge can act as traps for positrons. The effect saturates at high neutron fluence around 7×10^5 n/cm^2. The annihilation rate in saturated samples decreases further upon annealing around 200°C. The mean electron densities of the positron-sensitive defect after irradiation and after the 200°C annealing are 35% and 49% less than that in the perfect part of the crystal respectively. It is concluded that the non-planar vacancy clusters may be formed during the 200°C annealing. All positron-sensitive defects disappear upon annealing below and around 350°C. (auth)

4107 AMORPHIZATION BY FISSION FRAGMENT IRRADIATION OF Pd–Al ALLOYS. Lesueur, D. (CEN, Fontenay-aux-Roses, France). Radiat. Eff.; 24: No. 2, 101-110(1975). (In French).

An experiment is described in which it is possible to distinguish the respective effects of atomic collisions and electronic excitation in the amorphization of a Pd–Si alloy by irradiation with fission fragments. It is shown that in such an alloy, where covalent bonding exists, electronic excitation induces a "thermal spike" which causes sputtering at the sample surface and, in the bulk, amorphization or local order modification. Atomic collisions also induce amorphization of this alloy. The volume thus amorphized includes not only displaced atoms but also their nearest neighbors as if breaking of some bonds leads to a local reordering of the atoms. (auth)

4108 EFFECTS OF ELECTRON IRRADIATION ON CREEP OF ALUMINUM. Bystrov, L. N.; Ivanov, L. I.; Martinshin, O. V. (Inst. of Metallurgy, Moscow). Radiat. Eff.; 24: No. 2, 111-115 (1975).

Theoretical analysis of the effects of radiation on creep of metals, made on assumption of predominance of radiation-enhanced interstitial diffusion, has shown that irradiation should accelerate the motion of vacancy-emitting dislocation jogs, while, on the other hand, slowing down the motion of jogs emitting interstitials. Under such conditions, irradiation should slow down the creep controlled by jogged screw dislocation glide, and increase the creep rate, when it is controlled by edge dislocation climb. The conclusion to this effect was substantiated by experimental study of the effects of electron irradiation on creep of aluminium within the temperature range of 10 to 50°C. It was found that electron irradiation causes the creep rate to decrease; simultaneously, a substitution is observed of a mechanism controlled by the glide of jogged screw dislocations by one controlled by edge dislocation climb. (auth)

4109 METHOD OF DETERMINING THE THERMOPHYSICAL PROPERTIES OF METALS IN THE SOLID STATE. Prilepin, V. I. (Physical-Technical Inst., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk; No. 1, 29-32(1975). (In Russian).

This article proposes a formula connecting the ratio of the thermal conductivity to the product of the electrical conductivity by the absolute temperature with the heat capacity of a metal by means of a coefficient R_ϕ. Values of this coefficient are found for solid metals in regions of low, average, and high relative temperatures (relative to the characteristic Debye temperature). It was established that R_ϕ varies linearly with temperature. On the basis of experimental data on heat capacity and calculated values of the coefficient R_ϕ, the Lorentz coefficient of the metals under study (Be, Al, Ti, Cr, Fe, Ni, Cu, Zn, Zr, Nb, Mo, Ag, Ta, W, Au, Pb) was calculated. Good agreement with experimental data was obtained. (SJR)

4110 BEHAVIOUR OF SURFACES UNDER ION BOMBARDMENT. McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Rep. Progr. Phys.; 38: No. 2, 241-327(Feb 1974).

The processes involved when ions bombard surfaces have been divided into two categories for the purposes of review: those due to elastic collisions, i.e., sputtering and ion scattering; and those due to inelastic collisions, leading to excitation and ionization, resulting in the emission of x-rays, optical photons and electrons. In the case of ion scattering and sputtering a detailed review is given of the mechanisms involved. The experimental energy and angular distributions of the secondary particles were considered in both cases and compared with current theories. In addition, in a separate section, the effect of sputtering on the erosion of surfaces - including recent theories of the development

of topographical changes - is outlined. Also discussed under the heading of topographical damages are the effects of radiation blistering - and the effects of radiation damage on surface topography. In the discussion of inelastic effects consideration is first given to secondary electron emission due to incident ions. Results for total yields, the statistics of secondary electron emission, and the energy distribution of the secondary electrons are outlined. X-ray emission due to light and heavy ions is treated, and the recent discovery of molecular x-rays together with various other solid-state effects are discussed. Finally the emission of optical photons due to the de-excitation of excited sputtered and scattered atoms is treated. The review attempts to outline some of the applications of the various effects considered. (auth)

4111 PROTON-SIMULATED IRRADIATION-INDUCED CREEP. Hendrick, P. L.; Bement, A. L. Jr.; Harling, O. K. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Nucl. Instrum. Methods; 124: No. 2, 389-395(1 Mar 1975).

An experimental technique is described to measure the proton simulated irradiation-induced creep rate of metal specimens stressed in tension. A preliminary result employing this technique is presented for pure nickel specimens. (auth)

4112 THE EFFECTS OF TEMPERATURE CHANGES ON VOID SWELLING. Bullough, R.; Hayns, M. R. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). J. Nucl. Mater.; 55: No. 3, 237-245(Mar 1975).

The established rate theory of Brailsford and Bullough for the swelling in irradiated materials was extended to allow the temperature to change during irradiation. When the temperature first falls a secondary population of voids is nucleated and the theory presented determines both the incubation dose required to nucleate such voids and the kinetics of overall swelling resulting from the growth of the voids in such a bimodal distribution. Several illustrative examples are presented which demonstrate the versatility of the theory and the various possible physical consequences of such temperature changes, with or without the presence of an external tensile stress. (auth)

4113 MONOVACANCY FORMATION ENERGY IN COPPER, SILVER, AND GOLD BY POSITRON ANNIHILATION. Triftshaeuser, W.; McGervey, J. D. (Kernforschungsanlage Juelich G. m. b. H. (F. R. Germany). Inst. fuer Festkoerperforschung). Appl. Phys.; 6: No. 2, 177-180(Mar 1975).

3 figs.; 1 tab.; 15 refs.

Monovacancy formation energies in copper, silver, and gold were deduced from the temperature variation of the peak counting rate in the angular correlation curve of positron annihilation radiation from these metals. The counting rate was temperature dependent over the entire temperature range, including temperatures so low that no trapping of positrons at vacancies is effective. At these temperatures the increase in counting rate results from thermal expansion of the lattice. By separating this thermal expansion effect from the vacancy trapping effect at higher temperatures, values were obtained for the monovacancy formation energy E_{1v} for copper, silver, and gold to 1.29 ± 0.02 eV, 1.16 ± 0.02 eV, and 0.97 ± 0.01 eV, respectively. (auth)

4114 PRECIPITATION IN COPPER–NICKEL ALLOYS FOLLOWING HEAT TREATMENTS AND NEUTRON IRRADIATIONS. Schuele, W.; Spindler, P.; Lang, E. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center; Commission of the European Communities, Petten (Netherlands). Joint Nuclear Research Center). Z. Metallk.; 66: No. 1, 50-56(Jan 1975). (In German).

8 figs.; 1 tab.; 53 refs.

Precipitation following heat treatments and neutron irradiations in twelve different Cu–Ni alloys with nickel contents from 35 to 85 wt.% was studied by electrical resistivity techniques. The alloy with 70% Ni had the largest change in electrical resistivity due to the precipitation, which was already detectable below 700°C. The decrease of electrical resistivity due to the magnetic transformation is superimposed on the change due to the precipitation if the electrical resistivity is measured below the Curie temperature. The two resistivity contributions can be separated by varying the measuring temperature. A great enhancement of precipitation was observed in a Cu–Ni alloy containing 55% Ni during a neutron irradiation at temperatures between 100 and 150°C. The rate of the precipitation process during the irradiation was found to depend on interstitial diffusion. The migration activation energy of interstitials in this alloy was determined to be 1.1 eV. (auth)

4115 THEORY OF IRRADIATION INDUCED GROWTH OF FATIGUE CRACKS. Weertman, J. (Los Alamos Scientific Lab., N. Mex. (USA)). J. Nucl. Mater.; 55: No. 3, 253-258(Mar 1975).

A new type of irradiation damage is considered. It is proposed that the localized stresses that fluctuate both with time and with position in solids subjected to bombardment by energetic neutrons (or ions) can cause pre-existing cracks to grow in the same manner that fatigue cracks grow. Using a suitably modified Paris equation for fatigue crack growth it is calculated that cracks in niobium subjected to bombardment by 14 MeV neutrons grow at a rate of about 5×10^{-10}m per stress pulse exerted at the crack tip. This growth rate is at the threshold level measured in conventional fatigue crack growth experiments. Thus it is not certain whether indeed cracks in irradiated solids will grow. If cracks do grow by the proposed fatigue mechanism they may seriously limit the life of the first wall material of fusion reactors. The crack growth mechanism cannot explain the chunk formation observed in the experiments of Kaminsky et al. but they might explain chunk formation under fluences many orders of magnitude greater than used by them. (auth)

4116 THE PRIMARY RECOIL SPECTRUM IN THE SIMULATION OF FAST-REACTOR RADIATION DAMAGE BY CHARGED-PARTICLE BOMBARDMENT. Marwick, A. D. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). J. Nucl. Mater.; 55: No. 3, 259-266(Mar 1975).

The energy spectrum of primary knock-on atoms in iron subject to a typical fast-reactor neutron spectrum is calculated and compared to the PKA spectrum calculated in nickel under bombardment by 46.5 MeV nickel ions (as on the Harwell VEC), 5 MeV nickel ions, 22 MeV carbon ions, 5 MeV protons and 1 MeV electrons. The damage produced by each PKA spectrum is calculated, and the proportion of the damage produced by high-energy recoils estimated. Comparison of the PKA spectra indicates that the nickel ion bombardments are the closest simulation of fast-reactor damage. (auth)

4117 THE UTILIZATION OF A DUAL IRRADIATION FACILITY TO EXAMINE THE EFFECT OF HYDROGEN ON VOID SWELLING IN ALUMINIUM. Evans, J. H.; Buckley, S. N.; Manthorpe, S. (UKAEC Research Group, Harwell. Atomic Energy Research Establishment). J. Nucl. Mater.; 55: No. 2, 233-235 (Feb 1975).

The use of aluminium alloy components in water reactors raises the question of whether the high solubility of aluminium for hydrogen might in some circumstances cause the void-swelling characteristics of the metal to be adversely affected. The setting up of a dual irradiation accelerator facility provided the means of examining this question since the irradiation damage from self-ions could be investigated with and without the addition of prior or simultaneous proton bombardment. In the present experiment, the appropriate combination involved the use of 400 keV Al^+ ions for damage production and 60 keV protons to provide the hydrogen supersaturation. The main conclusion is that within the experimental accuracy of the experiments, no change in the void swelling characteristics is apparent as a result of the added protons, whether they were pre-injected or simultaneously injected into the aluminium. (auth)

4118 RE-IRRADIATION EFFECT ON NUCLEATION OF VOIDS IN STAINLESS STEEL. Hishinuma, A.; Katano, Y.; Fukaya, K.; Shiraishi, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). J. Nucl. Mater.; 55: No. 2, 227-228(Feb 1975).

In the course of the study on nucleation and growth of voids in a stainless steel by using a high voltage electron microscope, it was observed that the number density of the voids was remarkably increased by interruption of irradiation (aging) and re-irradiation. The purpose of this note is to describe the evidence and a qualitative interpretation. The specimen was prepared from Type 316 stainless steel annealed for 10 min at 1100°C and water quenched. After electro-polishing in a solution of 54% H_3PO_4, 36% H_2SO_4 and 10% C_2H_5OH at 10°C, the specimen was irradiated at 550°C with an electron flux of 3.7×10^{19} cm^{-2} · sec^{-1} in a JEM-1000D operating at 1 MV. The electron flux corresponds to a damage rate of 2×10^{-3} dpa · sec^{-1}. The thickness of the electron irradiated area of the specimen was estimated to be about 0.4 μm by counting the number of equal-thickness fringes at the grain boundary. In the present experiment, the number density of the voids increases abruptly after the 15 min irradiation following the aging and almost saturates within a few minutes. The facts indicate that the voids nucleate during the aging; if the voids would nucleate during the irradiation after aging, number density of the new voids should increase gradually with irradiation time as in the case of the first irradiation. (auth)

4119 THE EFFECT OF FISSION FRAGMENT IRRADIATION UPON THE OXIDATION OF A 20%Cr, 25%Ni, Nb STABILIZED AUSTENITIC STEEL BY OXYGEN AT 870°C. Bennett, M. J.; Chaffey, G. H. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). J. Nucl. Mater.; 55: No. 2, 224-226 (Feb 1975).

The effect was studied of fission fragment irradiation upon the oxidation behavior in oxygen of a 20% Cr/25% Ni, niobium-stabilized (20/25/Nb) stainless steel at 650 and 800°C. At the lower temperature, the extent of oxidation after 3700 h was increased by a factor of between 2 and 4 by irradiation with a fission fragment flux of 7×10^8 ff/cm^2 · sec. The enhanced attack was attributed to displacement damage in the protective oxide film. In contrast, at 800°C fission-fragment irradiation did not influence significantly either the magnitude of oxidation or the percentage of non-adherent oxide formed. In these experiments the maximum exposure period was 4252 h and the fission-fragment flux was between 1.13 and 1.53×10^9 ff/cm^2 · sec. The absence of a fission recoil bombardment effect at 800°C could arise from either a fast thermal reaction masking an irradiation-induced reaction or the rapid annealing of displacement damage. Nevertheless, it is conceivable that with higher fission-fragment fluxes the irradiation processes would be of sufficient magnitude to affect oxidation at high temperatures. To extend knowledge in this area, further experiments have been carried out with both a higher fission-fragment flux of ~10^{11} ff/cm^2 · sec and a higher experimental temperature of 870°C. The results of these experiments indicate that irradiation, with this fission-fragment flux and the incident reactor radiations, had not affected either the kinetics or the extent of oxidation of the 20/25/Nb steel by oxygen at 870 ± 40°C or the adherence of the oxide films formed. (auth)

4120 A THEORETICAL EXAMINATION OF THE EFFECT OF IRRADIATION-ENHANCED DISSOLUTION ON DIFFUSION-CONTROLLED COARSENING KINETICS. Bilsby, C. F. (UKAEA Reactor Group, Salwick). J. Nucl. Mater.; 55: No. 2, 125-133(Feb 1975).

Wagner's analysis of the diffusion-controlled coarsening of a dispersion of spherical particles was modified to include irradiation-enhanced dissolution. The effect of enhanced dissolution on the particle size distribution, the cubic time law of coarsening and particle volume density can be expressed in terms of the "dissolution parameter", defined as the ratio of the rate of irradiation-enhanced dissolution to that of thermal coarsening. The treatment given is valid for small values of this parameter. (auth)

4121 EFFECT OF FAST-NEUTRON IRRADIATION ON MECHANICAL PROPERTIES OF STAINLESS STEELS: AISI TYPES 304, 316 AND 347. Higgy, H. R.; Hammad, F. H. (Atomic Energy Establishment, Cairo (Egypt)). J. Nucl. Mater.; 55: No. 2, 177-186(Feb 1975).

The effect of low-temperature (<100°C) fast-neutron irradiation on the room-temperature tensile and hardness properties of stainless steels, AISI Types 304, 316, and 347 was investigated up to a fluence of 1.43×10^{20} n/cm^2 (E > 1 MeV). Several methods were used for analysis of results and the approach using the irradiation-induced increase in yield stress, $\Delta\sigma = \sigma_i - \sigma$, where σ_i and σ are the yield stresses of irradiated and unirradiated specimens, respectively, proved to be the best for describing irradiation-hardening. Below saturation fluence, ~$4\text{-}5 \times 10^{19}$ n/cm^2 (E > 1 MeV), it was shown that $\Delta\sigma \propto (\phi t)^{\frac{1}{2}}$ in agreement with Seeger's model. Yield points were observed at a fluence of 1.3×10^{19} n/cm^2 (E > 1 MeV) and above. The results are discussed in relation to transmission electron microscopy results of irradiated materials. The relation between irradiation-induced changes in yield stress and Vickers hardness was described by $\Delta H = K\Delta\sigma$, where K = 2.82 for AISI Type 304, and 3 for both AISI Type 316 and AISI Type 347. (auth)

Other Materials

Refer also to abstracts 3581, 4167, 4495, 4754, and 5359.

4122 (WANL-TMI-1803) COMPACTION PROPERTIES OF PYROFOIL PDS 30182-2. HENGSTENBERG, T. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Jul 1967. 10p. Dep. NTIS $4.00.

Results of tests at ambient temperature on layered stacks of pyrofoil are presented. Results show that approximately 70% of the initial compaction under 5 psi loading is lost as permanent set upon unloading. This results in an 8% reduction in foil thickness. This means that the process of forming and cementing the sleeves may result in an appreciable reduction in thickness. Dimensioning of the undercut will, therefore, have to be precisely controlled to maintain adequate sealing between the elements. Subsequent recycling at the same stress level results in little or no additional permanent set. Compaction in subsequent loading is reduced approximately 70% from initial cycle. Upon complete release of load, recovery of the permanent set from three low load cycles is at a rapid rate during the first 45 minutes—approximately 45%, increasing to only 60% at the end of 16 hours. The compaction rate per unit load drops very rapidly under successively increasing loads. This rate is down 80% in the third loading cycle at 20 psi. (auth)

4123 (WANL-TNR-140) INVESTIGATION OF STATIC AND DYNAMIC COEFFICIENT OF FRICTION. Manjoine, M. J.; Harrington, G. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Sep 1963. 24p. Dep. NTIS $4.25.

Declassified 10 Sep 1973.

The low friction of graphite results from a gas film on surface platelets. Therefore, if graphite is one of the materials in a rubbing combination, the coefficient of friction at room temperature in air, hydrogen, or nitrogen will reduce to about 0.2 in a few rubbing cycles for surface pressures within the elastic range. In hydrogen, graphite combinations have lower friction with increasing temperature. For metal on graphite, the friction decreases with temperature until a surface reaction occurs after which it increases with rising temperature. Removal of surface films causes an increase in friction. This can be accomplished for graphite by outgassing (heating in a vacuum). Only a partial pressure of hydrogen is necessary, however, to reduce the coefficient to 0.2 at room temperature. Niobium carbide surfaces have an increase in friction for air, hydrogen, or vacuum with increase in temperature. The coefficient reaches unity at 4000°R. (auth)

4124 APPLICATION OF SUSSMANN'S QUANTUM DIFFUSION MODEL TO NMR DIFFUSION MEASUREMENTS OF H IN UH_3. Peretz, M. (Soreq Nuclear Research Centre, Yavne, Israel); Cinader, G.; Zamir, D.; Hadari, Z. Collect. Phenomena; 2: No. 1, 37-40(Jan 1975).

Spin-spin relaxation time T_2 of hydrogen nuclei in β-UH_3 has been measured using NMR technique. An Arrhenius type behavior of T_2 has been observed. The activation energy of the hydrogen diffusion E_a = (19.25 ± 0.4) kcal/mole, and the pre-exponential factor $A_0 \simeq 2 \times 10^{15}$ Hz have been obtained. It is shown that these results are in good agreement with T_1 data. Explanation of the large magnitude of the diffusion parameters, using Sussmann's quantum model for diffusion, is proposed. (auth)

4125 ASSESSMENT OF ION IMPLANTATION DAMAGE USING THE SCANNING ELECTRON MICROSCOPE. Schulson, E. M.; Marsden, D. A. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Radiat. Eff.; 24: No. 3, 195-198(1975).

The assessment of ion implantation damage through the use of the scanning electron microscope (SEM) is discussed. Emphasis is placed on the method of analysis and on the limitations and the unique features of the technique. SEM assessments are made of the lattice disorder produced by the implantation of 40 keV Hg ions into boron-doped silicon crystals at room temperature, and are shown to be in quantitative agreement with Rutherford scattering measurements. Both methods show that the damage approaches saturation at a dose of $\approx 4 \times 10^{13}$ ions/cm^2, and both show that boron concentrations in the range 10^{17} to 10^{20} atoms/cm^3 have no significant effect on the susceptibility of silicon to ion implantation damage. (auth)

4126 DETERMINATION OF DEEP TRAP LEVELS CAUSED BY ION IMPLANTED IMPURITIES IN SILICON. Schulz, M. (Fraunhofer-Gesellschaft, Freiburg i. B.). pp 226-233 of Metal-Semiconductor Contacts. New York; American Inst. of Physics (1974).

From conference on metal-semiconductor contacts; Manchester, UK (3 Apr 1974). See CONF-740497-.

A new capacitance–voltage measurement technique on Schottky barrier contacts was developed which permits an easy and quick determination of energy levels, charge, and concentration profiles. In the new method, background doping and deep levels are separated by making use of the sharply peaked implantation profile. An "apparent" doping profile is obtained by differentiation of the measured C–V curves. In this profile, the peaked impurity distribution appears shifted from its real position deeper into the bulk material. The energy position of the level can be determined from the shift. Donor or acceptor behavior is identified by the shape of the apparent profile measured. The technique was applied to obtain data for 29 different elements implanted into silicon. The deep levels were measured after annealing of the radiation damage. Most of the energy levels determined agree with values known from the literature, but special levels associated with the implantation technique were also found. (auth)

4127 NOTE ON THE ISOTHERMAL DECAY METHOD FOR DETERMINING TRAP DEPTH FROM GLOW CURVES. Takeuchi, N.; Inabe, K.; Nanto, H. (Kanazawa Univ., Japan). J. Mater. Sci.; 10: No. 1, 159(Jan 1975).

Reference is made to publications on methods for determining trap depth from glow curves (Shalgaonkar et al., J. Mater. Sci.; 7: 1465(1972) and Chen, J. Mater. Sci.; 9: 345(1974)). It is sug-

gested that the analysis based on the shape of the glow curve over a range of temperature may be perturbed by interfering effects, and that the isothermal decay analysis is the only method unaffected by temperature. (UK)

4128 SURFACE TEMPERATURE MEASUREMENTS FOR ION-BOMBARDED Si AND GaAs AT 1.0 TO 2.0 MeV. Lowe, L.F.; Kennedy, J.K.; Davies, D.E.; Deane, M.L.; Eyges, L.J. (Air Force Cambridge Research Labs., Hanscom AFB, Massachusetts 01731). Rev. Sci. Instrum. 46: No. 5, 633-634 (May 1975).

Surface temperatures of ion-bombarded silicon and gallium arsenide have been measured using an infrared detector. Ion beams of N^+, N^+_2, O^+, O^+_2, C^+, CO^+, and H^+ were used at energies from 1–2.0 MeV and at current densities up to 12 $\mu A \cdot cm^{-2}$. No temperature dependence was found on ion species, energy, or current. The change in temperature depended only on beam power, target material, and sample mounting technique. With proper mounting temperature increases of 20 °C for silicon and 65 °C for gallium arsenide were observed for a beam power density of 1.0 $W \cdot cm^{-2}$. (auth)

4129 RESIDUAL DEFECTS IN Si PRODUCED BY RECOIL IMPLANTATION OF OXYGEN. Moline, R.A.; Cullis, A.G. (Bell Laboratories, Murray Hill, New Jersey 07974). Appl. Phys. Lett. 26: No. 10, 551-553 (15 May 1975).

The defect structures remaining in Si wafers after implantation of O^+ and As^+ ions together with subsequent annealing treatment have been studied using the transmission electron microscope. For implantation of 10^{16} 150-keV As^+/cm^2 through 430 Å of SiO_2 and subsequent annealing at 1000 °C in dry N_2, the resulting defect structures show many similarities to those obtained following a $1–2\times10^{16}$ 10-keV O^+/cm^2 implantation and annealing sequence. However, if 150-keV As^+ ions are implanted into bare Si, the general lattice disorder remaining after annealing is much smaller and the residual defects are much more widely spaced. The differences between the residual defects produced by the different As^+ implantations are interpreted with the proposal that the recoil of oxygen from SiO_2 is an important by-product of implantations through SiO_2 layers. (auth)

4130 ION-INDUCED MIGRATION OF Cu INTO Si. Hart, R.R.; Dunlap, H.L.; Marsh, O.J. (Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, California 90265). J. Appl. Phys. 46: No. 5, 1947-1951 (May 1975).

Ion bombardment of Cu-contaminated Si surfaces with either 20-keV Ne^+ or 800-eV Ar^+ ions leads to enhanced migration of Cu into the bulk of the Si to depths comparable to the projected range of the incident ions. The migration proceeds sufficiently rapidly to prevent sputter removal of submonolayer amounts of Cu even though as much as 100 Å of the substrate is sputtered away. The enhanced migration is probably caused by defect production during the slowing down of the incident ions. The depth distribution of the Cu following Ne^+ or Ar^+ bombardments was determined from backscattered energy spectra of 280-keV α particles. (auth)

4131 STRESS-GENERATION AND UNLOADING PROPERTIES OF PULSE-HEATED POROUS CARBON DETERMINED BY A SIDE GAUGING TECHNIQUE. Benson, D.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 46: No. 5, 2092-2100 (May 1975).

Measurement of the thermomechanical response of a porous carbon induced by a pulsed electron beam and the associated relief-wave velocities for the stress pulse unloading are described. These measurements are sufficient to determine an effective Grüneisen coefficient for energy inputs to 500 cal/g. The measurements are accomplished with a new side gauging technique which does not require wave propagation out of the heated region of the sample. A laser interferometer system is used to detect the lateral displacement of a target free surface vs time for the microsecond time duration immediately following deposition. The displacement-time measurement also permits detection of the unloading wave velocity in the heated material. Through use of a porous-solid collapse model (the P-α model), comparisons of the present results to computer calculations of the displacement-time profile show significant differences from the observed wave profiles. (auth)

4132 GROWTH OF FINE HOLES IN POLYETHYLENETEREPHTHALATE FILM IRRADIATED BY FISSION FRAGMENTS. Komaki, Y.; Tsujimura, S. (Division of Chemistry, Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken, Japan). J. Appl. Phys. 46: No. 5, 2101-2102 (May 1975).

Growth of fine holes by chemical etching in polyethyleneterephthalate films exposed to fission fragments were followed by measuring gas flow through films. The etching rate along tracks and the radial etching rate were determined at hole diameters of 100–3000 Å and hole densities of $10^6–10^9/cm^2$. (auth)

4133 THERMAL HYSTERESIS OF THE FARADAY EFFECT IN EPITAXIAL $Gd_3Fe_5O_{12}$ FILMS. Burak, Y.V.; Babin, V.P.; Savitskii, V. G. (I. Franko State University, L'vov). Sov. Phys.—Solid State 16: No. 9, 1773 (Mar 1975).

We report the observation of thermal hysteresis of the Faraday effect in epitaxial films of GdIG. We reject the hypothesis that the hysteresis is due to the rotation of the iron sublattices from the antiparallel to the parallel configuration. (AIP)

4134 NATURE OF A TRANSITION FROM WEAKLY FERROMAGNETIC TO ANTIFERROMAGNETIC STATE IN ORTHOFERRITES. Belov, K.P.; Zvezdin, A.K.; Kadomtseva, A.M.; Krynetskii, I.B.; Ovchinnikova, T.L. (M. V. Lomonosov State University, Moscow). Sov. Phys.—Solid State 16: No. 9, 1698-1700 (Mar 1975).

A transition from the weakly ferromagnetic to the antiferromagnetic state, accompanied a reorientation of the spins in the bc plane, occurred in a single crystal of $DyFe_{0.994}Co_{0.006}O_3$ near 130°K. A study was made of the influence of the magnetic field on the nature of this transition. The theoretical and experimental phase diagrams were plotted. The influence of the domain structure on the transition was considered. (auth)

4135 EFFECT OF IRRADIATION-INDUCED LATTICE STRAIN ON THE WIDTH OF LOCAL MODE ABSORPTION LINES IN SILICON. Totterdell, D. H. J.; Newman, R. C. (Univ. of Reading, Eng.). J. Phys., C (London); 8: No. 5, 589-598(7 Mar 1975).

Samples of silicon doped with oxygen alone, or with oxygen and carbon were irradiated with fast neutrons up to a maximum dose of 10^{20} cm^{-2}. It is shown that there is a progressive decrease in the resolution of the fine structure of the 9 μm band due to oxygen, and a corresponding increase in the width of the band at 12 μm due to $[O-V]^0$ centers. These measurements show a correlation with the growth of one-phonon band mode absorption. Measurements were also made on samples containing group III and/or group V impurities; the degree of disorder in these samples is greater showing that there are important impurity effects. These results are compared with the structure of the 9 μm band found in silicon after implantation with 400-keV oxygen ions. (auth)

4136 ANALYSIS OF THE GROUND TERM ENERGY LEVELS FOR TRIPLY IONIZED NEODYMIUM IN YTTRIUM ORTHOVANADATE. Karayianis, N.; Morrison, C.A.; Wortman, D.E. (Harry Diamond Laboratories, Washington, D.C. 20438). J. Chem. Phys. 62: No. 10, 4125-4129 (15 May 1975).

An investigation has been made of the ^4I ground term of Nd^{3+} in YVO_4. Wavelength and polarization measurements of the absorptions in the wavelength range 0.8–2.6 μm were used to establish energy levels for the $^4F_{3/2}$, $^4I_{9/2}$, $^4I_{13/2}$, and $^4I_{15/2}$ multiplets. These data were correlated with reported spectra in the literature, and an energy level scheme was obtained that identifies 25 out of the possible 26 ground term levels. By diagonalizing the Hamiltonian $H = \Sigma\ \lambda_n\ (L\cdot S)^n + \Sigma\ B^+_{km}\ C_{km}$ in an LS basis and performing a least-squares calculation, an rms deviation between calculated and experimental energy levels of 4.01 cm^{-1} was obtained. The parameter values giving this fit are $\lambda_1=293.74$, $\lambda_2=-2.454$, $\lambda_3=0.0389$, $B_{20}=-135.7$, $B_{40}=625.9$, $B_{60}=-1169.5$, $B_{44}=1023.9$, and $B_{64}=-251.4$ cm^{-1}. Theoretical values of $g_\parallel = -0.915$ and $g_\perp = 2.379$ are in good agreement with Ranon's reported values of $g_\parallel = \pm 0.915$ and $g_\perp = 2.348$ for the ground state; thus, the ground-state symmetry property was determined to be $\Gamma_{7,8}$ in S_4 notation or Γ_7 in D_{2d}. (auth)

4137 MECHANISM OF RADIATION-ACCELERATED DIFFUSION IN ION-IRRADIATED GALLIUM ARSENIDE. Pridachin, N.B.; Kachurin, G.A.; Smirnov, L.S. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). Sov. Phys.—Semicond. 8: No. 10, 1294-1294 (Apr 1975).

We have bombarded a sample of gallium aresenide with argon ions. We report on the effect this irradiation has on the diffusion of tin impurities.(AIP)

4138 X—RAY STUDY OF LEGHEMOGLOBIN. I. PURIFICATION, CRYSTALLIZATION, AND PREPARATION OF DERIVATIVES CONTAINING HEAVY ATOMS. Vainshtein, B.K.; Arutyunyan, É.G.; Kuranova, I.P.; Borisov, V.V.; Sosfenov, N.I.; Pavlovskii, A.G.; Grebenko, A.I.; Konareva, N.V. (Institute of Crystallography, Academy of Sciences of the USSR). Sov. Phys.—Crystallogr. 19: No. 5, 598-601 (Mar 1975).

A method is described for purifying leghemoglobin from nodules of the yellow lupine and preparing crystals of the protein suitable for x-ray structure analysis. Isomorphous derivatives of the leghemoglobin containing UO_2^{2+} and HgI_4^{2-} ions have been obtained. The parameters of the heavy atoms in these structures have been worked out by differential Patterson synthesis and confirmed by construction of differential electron density cross syntheses of the heavy atoms. (auth)

4139 X—RAY STUDY OF LEGHEMOGLOBIN. II. DETERMINATION OF THE STRUCTURE WITH RESOLUTION

OF 5 Å. Vainshtein, B.K.; Arutyunyan, É.G.; Kuranova, I.P.; Borisov, V.V.; Sosfenov, N.I.; Pavlovskii, A.G.; Grebenko, A.I.; Konareva, N.V. (Institute for Crystallography, Academy of Sciences of the USSR). Sov. Phys.—Crystallogr. 19: No. 5, 602-607 (Mar 1975).

The spatial structure of the leghemoglobin of the lupine *Lupinus leteus L.* has been determined with resolution of 5 A. Homology of the spatial structure of hemoglobins of plant and animal origin has been established with m=0.85. (auth)

4140 CRYSTALLOGRAPHIC CHARACTERISTICS OF PHOSPHATES AND ARSENATES OF TETRAVALENT ELEMENTS. Chernorukov, N.G.; Moskvichev, E.P.; Zhuk, M.I. (Gor'kii State University). Sov. Phys.—Crystallogr. 19: No. 5, 671-671 (Mar 1975).

Analysis of x-ray diffraction patterns on powders shows that the disubstituted phosphates and arsenates of titanium, zirconium, and hafnium form a series of isomorphous crystal structures in the monoclinic system. However, thorium arsenate with the same composition falls out of the series and forms a hexagonal crystal lattice. (AIP)

4141 Fe^{3+} EPR SPECTRUM IN IRRADIATED QUARTZ. Zaitov, M.M.; Zaripov, M.M.; Samoilovich, M.I.; Khadzhi, V.E.; Tsinober, L.I. (All-Union Scientific Research Institute for the Synthesis of Mineral Raw Materials, Aleksandrov). Sov. Phys.—Crystallogr. 19: No. 5, 674-675 (Mar 1975).

Artificial iron-doped quartz specimens grown on rhombohedral section seeds colored amethyst by γ irradiation were studied by EPR at 300, 77, and 4.2 °K. The results show that the Fe_{III}^{3+} spectrum does not belong directly to amethyst color centers. (AIP)

4142 PHASE DIAGRAM OF THE $Na(D_{0.13}H_{0.87})_3(SeO_3)_2$ CRYSTAL IN TEMPERATURE-RADIATION DOSE COORDINATES. Peshikov, E.V.; Shuvalov, L.A. (Institute of Nuclear Physics, Academy of Sciences of the Uzbek SSR). Sov. Phys.—Crystallogr. 19: No. 5, 679-680 (Mar 1975).

Results are presented which enable the phase diagram for the $Na(D_{0.13}H_{0.87})_3(SeO_3)_2$ crystal to be constructed in temperature-γ irradiation dose coordinates. It is also shown that in $Na(D_xH_{1-x})_3(SeO_3)_2$ having not too wide a temperature range of existence of the β phase (i.e., for $x < 0.3$ but close to 0.3) this phase disappears with sufficiently high doses of γ radiation. (AIP)

4143 DIFFUSE X—RAY SCATTERING BY IRRADIATED LiF, NaCl, AND KCl CRYSTALS. Zefirova, V.L.; Kolontsova, E.V.; Zhdanov, G.S.; Lutsenko, V.P. (M. V. Lomonosov Moscow State University). Sov. Phys.—Crystallogr. 19: No. 5, 686-687 (Mar 1975).

The diffuse scattering intensities for single crystals of LiF, NaCl, and KCl before and after electron irradiation and under identical conditions of experiment for electron, neutron, and x radiation are compared and correlated to defect formation. (AIP)

4144 LUMINESCENCE ROSETTE AROUND THE SITE OF ACTION OF A CONCENTRATED LOAD. Rozhanskii, V.N.; Vlednitskaya, M.A. (Institute of Crystallography, Academy of Sciences of the USSR). Sov. Phys.—Crystallogr. 19: No. 5, 688-689 (Mar 1975).

Magnesium oxide and corundum crystals, previously subjected to indentation, are irradiated by electrons (10-40 keV). A luminosity of bluish-violet color is observed around the depression formed by the indentor. The luminescence rosettes in MgO have rays in the ⟨110⟩ direction and are more than double the size of the indentor impressions. (AIP)

4145 INFLUENCE OF THE TEMPERATURE OF THE GROWTH OF FILAMENTARY CRYSTALS OF KCl ON THE CONCENTRATION OF POINT DEFECTS IN THE CRYSTALS. Melik-Gaikazyan, I.Y.; Deryabin, P.E.; Turgumbaev, K.T.; Lavryashina, T.V. (Kuzbass Polytechnical Institute). Sov. Phys.—Crystallogr. 19: No. 5, 696-697 (Mar 1975).

An attempt was made to control the original defect character of filamentary crystals by varying the temperature of their growth. The filamentary KCl crystals were grown through a collodion film from "very highly pure" grade salt with an integral concentration of divalent impurities $2.5 \cdot 10^{18}$ cm^{-3}. The kinetic curves for the accumulation of F centers under the influence of x rays were obtained on a microspectrophotometric assembly. The temperature dependence of log σ was recorded by a method which made it possible to significantly increase the area of the electrodes of the specimens being measured, and to decrease the lower temperature limit of the measurement of σ to 40 °C. (AIP)

4146 SELECTED ENGINEERING AND FABRICATION ASPECTS OF NUCLEAR METAL HYDRIDES (Li, Ti, Zr, AND Y). Van Houten, R. (General Electric Co., Cincinnati, Ohio (USA). Nuclear Systems Programs). Nucl. Eng. Des.; 31: No. 3, 434-448 (1974).

Metal hydrides are useful hydrogen reservoirs. Lithium, titanium, zirconium, and yttrium hydride systems are discussed, with attention to factors which affect both methods of fabrication and selection for nuclear and nonnuclear applications. The use of recently declassified boride and carbide additives and selective thermal arrest hydriding cycles are referenced. Collectively, these processes have simplified the manufacture of crack-free massive hydrides of a variety of hydridable metals and have improved the mechanical properties of the as-fabricated and the thermally aged hydrides. (auth)

4147 INFLUENCE OF PLATINUM ADDITIONS ON REDUCTION OF VANADIUM PENTOXIDE BY MOLECULAR AND ATOMIC HYDROGEN. Il'chenko, N. I.; Lavrenko, V. A.; Tikush, V. L.; Zenkov, V. S.; Golodets, G. I.; Frantsevich, I. N. (AN Ukrainskoi SSR, Kiev. Inst. Fizicheskoi Khimii. AN Ukrainskoi SSR, Kiev. Inst. Problem Materialovedeniya). Dokl. Akad. Nauk SSSR; 218: No. 5, 1136-1139(11 Oct 1974). (In Russian).

A study is presented on reducing by molecular and atomic hydrogen both V_2O_5 alone, and also V_2O_5 containing small amounts of Pt. The kinetics of the reduction were investigated gravimetrically. In the presence of the platinum catalyst the rate and degree of reduction increase sharply. From the data which were obtained it is possible to compose the following systems in order of decreasing reduction rate: V_2O_5 - 0.1% Pt - atomic hydrogen > V_2O_5 - 0.1% Pt - molecular hydrogen $\gg$ V_2O_5 - atomic hydrogen > V_2O_5 - molecular hydrogen. (tr-SJR)

4148 BLOCKING OF α-PARTICLES TRANSMITTED THROUGH GERMANIUM AND SILICON CRYSTALS. Schuch, R. (Goettingen Univ. (F. R. Germany). 2. Physikalisches Inst.). Z. Phys., A.; 272: No. 1, 61-66(1975). (In German).

5 figs.; 1 tab.; 6 refs.

The energy loss of channeled and blocked α-particles transmitted parallel to the [111] and also the [110] planes of germanium and silicon was investigated. In the spectrum of the transmitted α-particles measured with a small-acceptance-angle detector, in addition to the random and normally channeled α-groups a separated group with a high energy loss was observed in the direction of the [111] planes, while in the direction of the [110] planes this group is not well separated from the random α-group. A model is proposed which describes this high energy loss for observation in the direction of either plane. In agreement with this model a higher yield of α-particles with high energy loss in the [111] planes in comparison with the [110] planes of germanium and silicon was measured. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

4149 (LA-5794-MS) GUIDE TO GAMMA-RAY ASSAY FOR NUCLEAR MATERIAL ACCOUNTABILITY. Reilly, T. D.; Parker, J. L. (Los Alamos Scientific Lab., N. Mex. (USA)). Dec 1974. Contract W-7405-eng-36. 49p. Dep. NTIS $5.45.

The measurement of uranium- and plutonium-bearing materials using methods of gamma-ray spectroscopy is discussed. The report is meant to be a guide for a knowledgeable person and assumes the reader has at least a basic understanding of such matters as half-life and decay rate, gamma-ray interactions with matter (attenuation), detectors and detection processes, and the use of gamma spectroscopy equipment (detectors, multichannel pulse-height analyzers, and associated electronics). (TFD)

4150 SAFEGUARDS FOR FISSILE MATERIALS. II. Bookkeeping Aspects. Harry, R. J. S. Atoomenergie Haar Toepass.; 17: No. 3, 61-67(Mar 1975). (In Dutch).

The article goes thoroughly into the details of nuclear material accountancy, and the detection of discrepancies, undue deficits or excesses in fissile stockpiles etc. A number of statistical sampling techniques used in descrepancy estimation are described and assessed. (NL)

Disposal and Storage

Refer also to abstracts 3148, 3471, 3474, and 5630.

4151 (BNL-19673) SAVANNAH RIVER LABORATORY LONG-TERM WASTE STORAGE PROGRAM. Progress Report No. 8, October–December 1974. Colombo, P.; Steinberg, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y. (USA)). Jan 1975. 30p. Dep. NTIS $4.50.

The information given in this report is part of a study at Brookhaven National Laboratory (BNL) in support of the Savannah River Laboratory (SRL) development program for long-term engineered storage of solidified high-level radioactive wastes. The FY 1975 BNL program objectives are (1) the preparation of appropriate formulations of cements with synthetic sludges, synthetic slurries and zeolites and, (2) an evaluation of the properties of the radwaste-concrete composite materials. While the emphasis is now being placed on the development of cement-concrete composites containing cesium loaded zeolites and slurries, a major portion of the BNL study on the development of cement-concrete composites containing synthetic sludges has been completed. (auth)

4152 (BNWL-1865) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, AUGUST 1974. Division of Production and Materials Management and Hanford Plant Assistance Programs. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1974. Contract AT(45-1)-1830. 24p. Dep. NTIS $4.25.

Progress and research activities are reported on the following: storage of high-level liquid wastes; soil characteristics in Z trenches; tank farm support; prevention of accidental releases; ground water management studies; environmental evaluations; radiation protection; and radiation standards and engineering. (TFD)

4153 (BNWL–1868) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, SEPTEMBER 1974. Division of Production and Materials Management and Hanford Plant Assistance Programs. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1974. Contract AT(45-1)-1830. 18p. Dep. NTIS $4.00.

Research progress is reported on soil characteristics in Z trenches; tank farm support; prevention of accidental releases; ground water management studies; storage of high-level liquid radioactive wastes; environmental evaluations; radiation protection; and radiation standards and engineering. (TFD)

4154 (EPA-520/3-74-009) STORAGE OF LOW-LEVEL RADIOACTIVE WASTES IN THE GROUND: HYDROGEOLOGIC AND HYDROCHEMICAL FACTORS (WITH AN APPENDIX ON THE MAXEY FLATS, KENTUCKY, RADIOACTIVE WASTE STORAGE SITE: CURRENT KNOWLEDGE AND DATA NEEDS FOR A QUANTITATIVE HYDROGEOLOGIC EVALUATION). Papadopulos, S. S.; Winograd, I. J. (Geological Survey, Reston, Va. (USA)). 1974. 49p. Environmental Protection Agency, Washington, D. C.

Hydrogeologic criteria presented by Cherry and others (1973) are adopted as a guideline to define the hydrogeologic and hydrochemical data needs for the evaluation of the suitability of proposed or existing low-level radioactive waste burial sites. Evaluation of the suitability of a site requires the prediction of flow patterns and of rates of nuclide transport in the regional hydrogeologic system. Such predictions can be made through mathematical simulation of flow and solute transport in porous media. The status of mathematical simulation techniques, as they apply to radioactive waste burial sites, is briefly reviewed, and hydrogeologic and hydrochemical data needs are listed in order of increasing difficulty and cost of acquisition. Predictive modeling, monitoring, and management of radionuclides dissolved and transported by ground water can best be done for sites in relatively simple hydrogeologic settings: namely, in unfaulted relatively flat-lying strata of intermediate permeability such as silt, siltstone and silty sandstone. In contrast, dense fractured or soluble media and poorly permeable porous media (aquitards) are not suitable for use as burial sites, first, because of media heterogeneity and difficulties of sampling, and consequently of predictive modeling, and, second, because in humid zones burial trenches in aquitards may overflow. A buffer zone several thousands of feet to perhaps several miles around existing or proposed sites is a mandatory consequence of the site selection criteria. As a specific example, the Maxey Flats, Kentucky low-level waste disposal site is examined. (auth)

4155 BENEFITS OF A FORMAL WASTE MANAGEMENT PROGRAM. Wolfe, R. A. (Monsanto Research Corp., Miamisburg, OH). pp 35-38 of Energy and the Environment. Buonicore, A. J. (Ed.). Dayton, OH; American Inst. of Chemical Engineers (1974).

From 1st annual AIChE conference on energy and the environment; Oxford, Ohio, USA (25 Oct 1973). See CONF-7310101-.

The proper management of waste is of vital importance in the conservation of our environment. Mound Laboratory, which is operated by Monsanto Research Corporation for the U. S. Atomic Energy Commission, has embarked upon a waste management program designed to assure that the generation, processing, storage, and disposal of waste is conducted in such a manner as to have a minimum impact on the environment. The organizational approach taken toward waste management is discussed and some of the benefits of the waste management program at Mound Laboratory are described. It has been shown that the utilization of proper waste management techniques can have economic, as well as environmental protection, benefits. (auth)

4156 RADIOACTIVE WASTE DISPOSAL: A SURVEY. Bentsen, B. A. (Air Force Systems Command, Wright-Patterson AFB, OH). pp 89-93 of Energy and the Environment. Buonicore, A. J. (Ed.). Dayton, OH; American Inst. of Chemical Engineers (1974).

From 1st annual AIChE conference on energy and the environment; Oxford, Ohio, USA (25 Oct 1973). See CONF-7310101-.

The world's industrial nations are embarking on a major build-up of nuclear electric power generating capacity. Enormous quantities of radioactive waste will be produced in fuel reprocessing operations which must be safeguarded from entering the biosphere for thousands of years. It is an unprecedented problem which has no universally agreed upon solution. (auth)

Handling Equipment and Procedures

Refer also to abstract 3472.

4157 NUCLEAR SAFETY AND CRITICALITY IN WORKSHOPS AND LABORATORIES. Demant, J. T. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Inst. Nucl. Eng.; 15: No. 6, 171-174(Nov 1974).

The aim of those concerned with nuclear safety in reaction to fissile materials is stated to be elimination of the possibility of unintentional criticality, and the meaning of criticality and the need for preventative measures are discussed under the following headings: critical quantities; minimum critical mass; assessment and control of hazards; maximum "safe" quantities; and control of larger quantities. Reported criticality accidents are summarized. (UK)

Transportation

Refer also to abstract 4155.

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 4764 and 4960.

4158 (CNAEM-R-123) DETERMINATION OF THE CHARACTERISTICS OF THE ELECTRON BEAM EMITTED FROM A FEBETRON 705-B ACCELERATOR. Erkol, A. Y. (Cekmece Nuclear Research and Training Center, Istanbul (Turkey)). 1973. 82p. Dep. NTIS (US Sales Only) $7.25.

Thesis. Submitted to Salford Univ., England.

The characteristics of the electron beam emitted from a Febetron 705-B accelerator have been determined. Measurement of the voltage and current waveforms indicates that at a charging voltage of 30 kV the maximum beam energy is 1.5 MeV. The dose immediately in front of the tube window is of the order of Mrads and decreases by, e.g., 70% at 10 cm. The dose in a cross section of the beam obeys a Gaussian distribution, and the effective radius of the beam has been calculated to be 35.4 mm and 38.6 mm at 35 kV and 30 kV charging voltage and at low magnetic focusing field. Depth-dose profiles indicate that the equivalent electron energy increases from 1.12 MeV at 22 kV charging voltage to 1.55 MeV at 35 kV charging voltage. From the results, the optimum machine operating conditions for pulse-radiolysis experiments to be carried out, the optimum charging voltage and magnetic focusing field have been determined. (auth)

4159 (RL-74-157) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, July 1–September 30, 1974. Gray, D. E. (ed.). (Science Research Council, Chilton (UK). Rutherford Lab.). Dec 1974. 10p. Dep. NTIS (US Sales Only) $4.00.

The Nimrod beam was on for High Energy Physics Research for 86.6% of HEP scheduled operating time. Five experiments continued through in the period. Some details of modifications to two of the beams in Experimental Hall 3 are given. (auth)

4160 (RL-75-027) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report, October 1–December 31, 1974. Gray, D. E. (ed.). (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 22p. Dep. NTIS (US Sales Only) $4.25.

The Nimrod beam was on for High Energy Physics Research for 86.5% of HEP scheduled operating time. One experiment was completed and four continued through in the period. A further report on Nimrod's second RF accelerating system is given. This system has increased the circulating and consequentially the extracted proton beams of Nimrod by 40%. (auth)

4161 (RLO-1388-258) ANNUAL REPORT, 1974. (Washington Univ., Seattle (USA). Nuclear Physics Lab.). Jun 1974. 230p. Dep. NTIS $14.50.

Areas of major interest during this period were heavy-ion interaction mechanisms, the possibility of characterizing high-lying nuclear excitations as collective multipole excitations, the structure of levels in light nuclei as revealed by their decay modes, and the nature of proton interactions with nuclei as studied by polarized-proton beams. Other areas of interest were nuclear astrophysics, the parity-violating component of nuclear forces, and inner-shell ionizations of atoms produced by fast projectiles. There were also developments in the technological resources of the Laboratory, e.g., the improvement of the polarized ion source and the installation of an ion source in the high-voltage terminal of the injector stage of the FN tandem. The contents of the report are arranged under the following headings: accelerator development; ion source development; instrumentation, detectors, research techniques; the computer and computing; levels in light nuclei; nuclear astrophysics; weak interactions; scattering and reactions; reactions with polarized protons; heavy-ion reactions; photon emission from nuclear states; radiative capture; fission; atomic physics; medium-energy physics; energy studies; research by users and visitors; and appendix (personnel, publications, etc.). Items with a significant amount of information are cited separately in NSA. (RWR)

For abstracts or titles of individual papers see: 4171, 4455–4462, 4823–4836, 4879–4883, 4909, 4910, 4945, 5039–5042, and 5113.

4162 A NEW APPROACH TO ION ACCELERATION WITH ELECTRON BEAMS. Young, F.C.; Friedman, M. (Naval Research Laboratory, Washington, D. C. 20375). J. Appl. Phys. 46: No. 5, 2001-2004 (May 1975).

The propagation of an unneutralized relativistic electron beam with $v/\gamma > 1$ around a grounded wire creates a highly localized high-density plasma. Multi-MeV ions were observed to be accelerated collectively from this plasma by the electron beam. If a deuterated polyethylene wire is used up to 10^{14} deuterons with a mean energy of about 3 MeV are generated and directed along the axis of the wire. It was demonstrated that the acceleration mechanism is applicable to higher-atomic-number ions. If an aluminum wire is used 12–30-MeV aluminum ions are produced. (auth)

4163 HEAVY ION ACCELERATORS. Schmelzer, C. (GSI, Darmstadt, Ger.). pp 585-602 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

This review of the present state of work on heavy-ion accelerators pays particular attention to the requirements for nuclear research. It is divided into the following sections: single-particle versus collective acceleration, heavy-ion accelerators, beam quality, and a status report on the UNILAC facility. Among the topics considered are the recycling cyclotron, linacs with superconducting resonators, and acceleration to the GeV/nucleon range. (8 figures, 2 tables) (RWR)

4164 SOME APPLICATIONS OF PARTICLE ACCELERATORS TO CANCER RESEARCH AND TREATMENT. Almond, P. R. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex. (USA)). Phys. Rep.; 17: No. 1, 1-35(Mar 1975).

89 refs.

The applications of physics to medicine are reviewed and the responsibilities of the physicist in the three areas of radiological physics (radiotherapy, diagnostic radiology, and nuclear medicine) are outlined. The main part of the paper deals with the applications of accelerators in medicine, in particular radiotherapy and isotope production. For radiotherapy, a brief review of the history of the use of various types of accelerators in therapy is given and then a number of problems including beam shaping, neutron measurements around accelerators, and electron beam measurements are discussed as examples of the application of physics to cancer treatment. The physical and biological factors are then considered which may result in an advantage of neutrons, pions, or other heavy charged particles in (with respect to) cancer therapy over X-rays or electrons and a brief outline of work already underway in this area is presented. The production of isotopes by cyclotrons is then discussed. The advantage that these isotopes might have and a list of typical procedures that might be performed with them is given. (auth)

4165 ACCELERATION OF DOUBLY CHARGED C, N, AND O IONS AT A 3 MEGAVOLT VAN DE GRAAFF. Martin, F. W. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Nucl. Instrum. Methods; 124: No. 2, 329-333(1 Mar 1975).

The ion species emerging from the energy-analyzing magnet of a Van de Graaff accelerator fitted with a standard rf ion source have been studied with an electrostatic analyzer and semiconductor detectors. For N_2 and CO_2 gases, the most intense ion beams threading the magnet and analyzer are associated with fragmentation of molecular ions prior to the magnet. A typical current of the less intense doubly charged atomic ions is 20 nA at 5.5 MeV, limited by terminal x-rays. If air is introduced as an exchange gas prior to the analyzer an equilibrium charge-state distribution can be produced, containing trace quantities of C^{+5} or N^{+6} ions. (auth)

4166 THE PROSPECTS FOR DESIGNING A 0.5 to 1.0 MeV GAMMA-QUANTA GENERATOR FOR WELL LOGGING. Anatskii, A. I.; Vakhrushin, Yu. P.; Grumbkov, A. P.; Guseva, N. S.; Ivanov, Yu. M. (Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii, Moscow (USSR)). pp 179-191 of Skvazhinnye Generatory Nejtronov. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Institut Yadernoi Geofiziki i Geokhimii (1973). (In Russian)

12 refs.

The preliminary technical requirements which must be satisfied for a γ logging generator for high density γ-γ logging were formulated. The possibility of fabricating this type of generator based on different types of accelerating systems was examined. It was concluded that development of a logging generator based on a linear induction accelerator is possible. (tr-auth)

Auxiliaries and Components

4167 (CERN-75-3) RADIATION AND FIRE RESISTANCE OF CABLE-INSULATING MATERIALS USED IN ACCELERATOR ENGI-

NEERING. Schoenbacher, H.; Van de Voorde, M. H. (European Organization for Nuclear Research, Geneva (Switzerland)). 15 Apr 1975. 20p. Dep. NTIS (US Sales Only) $4.00.

Radiation and/or fire resistance tests are reported for the insulating materials of a large variety of electrical cables of possible use in the radiation environment of high-energy accelerators. Some 100 different samples, supplied by 16 European cable manufacturers, have been tested; they include polyvinylchloride, polyethylene, chlorosulfonated polyethylene, ethylene propylene rubber, and silicon rubber, but exclude butyl rubber and polytetrafluoroethylene because of their poor radiation resistance. An outline is given of the tensile strength, hardness and flame tests carried out on non-irradiated samples and on samples irradiated in the mixed neutron-gamma field of a nuclear reactor, with total integrated doses of $5 \times 10^7 - 5 \times 10^8$ rad. Based on the requirement of at least 100% elongation at break after exposure to 1×10^8 rad, the results show that about half of the tested materials can be considered usable for accelerators, at ambient temperature. Silicon rubber is resistant up to 80°C and 5×10^7 rad, whereas all tested materials become unusable at 5×10^8 rad. The fire resistance does not change significantly with irradiation. Also presented are results on shrinkage, brittleness, and gas evolution. Some recommendations on how to improve the radiation resistance of cable-insulating materials are included. (auth)

4168 (JINR-P10-8596) METHOD AND SCHEME FOR DETERMINATION OF THE MEDIAN TRACK COORDINATES BY SCANNING DEVICE. Gusev, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A method for determination of the median track coordinates by a scanning device is described. The method is realized with a small amount of electronics, the dead zone being absent. The electronic scheme is given. (auth)

4169 (RL-75-008) REPORT ON THE BASQUE SUPERCONDUCTING SOLENOID PROJECT. Gallagher-Daggitt, G.; Wilson, M. N.; Micklewright, C.; Brown, J.; Dawson, J.; Roberts, R.; Daniel, R. (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 64p. Dep. NTIS (US Sales Only) $6.25.

The Basque 6 Tesla meter superconducting solenoid is an operational beam live element to be used in a proton beam line of the TRIUMF cyclotron to process the spin axis of polarized protons in an experiment designed to measure the triple scattering parameters of the free neutron proton system in the energy range from 200 to 525 MeV. A performance evaluation of the superconducting solenoid is presented. (WHK)

4170 SELF-EXCITED WAVEGUIDE BUNCHER. Gavrilov, N.M.; Nesterovich, A.V. Sov. Phys.—Tech. Phys. 19: No. 8, 1085-1086 (Feb 1975).

The possible use of longitudinal beam instability in a slow wave system for a phase bunching before injection into a linear accelerator is analyzed. (auth)

Ion Sources and Injection and Extraction Systems

Refer also to abstract 4161.

4171 (RLO-1388-258, pp 73-75) NEW FAST SPIN-FLIP METHOD FOR A POLARIZED PROTON BEAM. Adelberger, E. G.; Swanson, H. F.; Trainor, T. A. Jun 1974.

In annual report, 1974.

4172 THE BRIGHTNESS AND EMITTANCE OF NEGATIVE ION BEAMS FROM A MIDDLETON SOURCE. II. Doucas, G.; Hyder, H. R. M.; Knox, A. B. (Oxford Univ. (UK). Nuclear Physics Lab.). Nucl. Instrum. Methods; 124: No. 1, 11-22(15 Feb 1975).

The intensity and emittance of the negative beam produced by a Middleton type sputter source have been measured for four ion species and a range of source parameters, namely cesium beam energy and intensity, cone aperture diameter, negative beam extraction geometry and negative ion suppression voltage. No evidence was found that the emittance depended on ion species. As a general rule, the best average brightness can be achieved by operating a high cesium current with a large cone aperture. Only for quite small currents is the brightness increased by using a small aperture. Increasing the beam energy at constant intensity resulted in an increase in emittance. The beam output was found to increase with cesium beam energy and intensity, and there was evidence of output saturation for cesium beams of high perveance. (auth)

4173 PRELIMINARY RESULTS WITH A PENNING ION SOURCE ON A 5.5 MV VAN DE GRAAFF ACCELERATOR. Heninicke, E.; Helleboid, J. M.; Weber, A. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Centre de Recherches Nucleaires). Nucl. Instrum. Methods; 124: No. 1, 301-303(15 Feb 1975).

In order to increase the intensities of the multiply-charged heavy-ion beams of the 5.5 MV Van de Graaff accelerator in Strasbourg, a Penning ion source with axial extraction was installed. The installation and the beam guiding system are discussed. The intensities of accelerated ions for different injected ion species and charge states are tabulated. (auth)

4174 A SOURCE FOR A VECTOR-POLARIZED LITHIUM-6 BEAM AT AN EN-TANDEM. Steffens, E.; Ebinghaus, H. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Experimentalphysik); Fiedler, F.; Bethge, K. (Heidelberg Univ. (F. R. Germany). 2. Physikalisches Inst.); Engelhardt, G.; Schafer, R.; Weiss, W.; Fick, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 2, 601-603 (1 Mar 1975).

A source for vector-polarized ^{6}Li ions produced by the atomic-beam method was installed at the Heidelberg EN-tandem accelerator. The first results are reported. ($i^{max}_{target} = 40$ nA $^6Li^{3+}$; $0.4 < P_{Li} < 0.6$). (auth)

4175 DEVELOPMENT OF AN AXIAL BEAM GUIDING SYSTEM FOR THE INJECTION OF POLARIZED IONS INTO THE ENERGY VARIABLE ISOCHRON-CYCLOTRON OF THE UNIVERSITY OF BONN. Scholzen, A. Bonn; Univ. Bonn (1974). 71p. (In German). INIS.

Thesis.

A beam guiding system was developed for the isochronous cyclotron of the University of Bonn to inject polarized ions. The beam is deflected by a hyperboloid inflector into the acceleration plane. With three single lenses and four electrical quadrupole lenses a transmission up to the inflector is achieved from 30% to 50% depending on the energy of the polarized protons and of 60% for a deuteron beam. (GE)

Ion Optics and Field Calculations

Refer also to abstract 3619.

4176 (IPP-0/23) DIPOLE INSTABILITY OF A RELATIVISTIC ELECTRON RING LOADED WITH TWO SPECIES OF IONS. Ott, W.; Dommaschk, W.; Springmann, E. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jul 1974. 7p. INIS.

The electrostatic interaction of a relativistic electron ring with the ions contained in it leads to instability under certain conditions, as is well known. Since there are always different ion species present in the ring, the influence of the ion mixture on the instability is investigated. A dispersion equation is derived in which, besides the interaction of the electrons with one ion species, both the collective interaction of the electrons with a second ion species and the collective interaction between the two ion species are taken into account. As solutions of these equations show, no excessive enhancement or suppression of the instability nor an appreciable displacement of the region of instability due to the additional interaction takes place. For sufficiently small fractional ion loading the region of instability splits into two regions corresponding to the separate interactions of each ion species with the electrons. (auth)

4177 (JINR-P9-8643) NET METHOD APPLIED IN CALCULATIONS OF THE EXCITATION FIELDS OF NONHOMOGENEOUS IDEAL CONDUCTING STRUCTURE BY THE MOVING ELECTRON BUNCH. Bakhvalov, N. S.; Bondarenko, V. S.; Zhidkov, E. P.; Rubin, S. B.; Serdyukova, S. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 19p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A new approach to the solution of the engineering-physical model problem on excitation of a closed structure by the moving electron bunch is described. The corresponding group of the Maxwell equations was solved by the difference scheme method. The method is efficient and gives more complete information when compared with the usual method of Fourier expansion. (auth)

4178 ANALYSIS OF A MAGNETIC DOUBLE SHEATH FOR ION BEAM ACCELERATION AND DECELERATION. Forrester, A.T. (University of California, Los Angeles, California 90024). J. Appl. Phys. 46: No. 5, 2051-2056 (May 1975).

It appears feasible to accelerate or decelerate an intense ion beam without using material grids. Instead, a virtual grid can be established by the use of a crossed field flow of electrons using a uniform magnetic

field perpendicular to the ion flow direction. The problem of the magnetic double sheath formed by the intense ion beam and a crossed electron flow has been analytically solved and can readily be applied to any given ion beam situation. The required electron current densities and magnetic fields appear to be moderate in all cases and some examples are presented. (auth)

4179 CALCULATION TO FIRST ORDER OF THE EFFECTS OF FIELD ERRORS IN A 90° DOUBLE-FOCUSING MAGNET. Joy, T.; Tait, N. R. S. (SEE CODE- 5677740 Science Research Council, Daresbury (UK). Daresbury Nuclear Physics Lab.). Nucl. Instrum. Methods; 124: No. 2, 485-489(1 Mar 1975).

The effects of various types of magnetic-field error on the calibration and resolution have been calculated for a double-focusing 90° magnet. The magnet has been divided into a number of segments to which field-magnitude and field-gradient errors have been applied. The effects of the errors are determined using ray-tracing techniques based on first-order optics. (auth)

Storage Rings

Refer also to abstract 3601.

4180 (BNL-20012) s EQUALS 3600 IS ALSO NECESSARY. Foley, K. J. (Brookhaven National Lab., Upton, N. Y. (USA)). 23 Apr 1975. 6p. Dep. NTIS $4.00.

The fact that ISABELLE is designed to operate over the energy range 30 + 30 GeV to 200 + 200 GeV is pointed out for clarification of the capabilities of ISABELLE. (s is the square of the center-of-mass total energy.) (WHK)

4181 (COO-3071-134) MEASUREMENT OF THE RADIATIVE ELECTRON POLARIZATION IN A 2.4 GeV STORAGE RING. Camerini, U.; Cline, D.; Learned, J.; Mann, A. K.; Resvanis, L. K. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics; Wisconsin Univ., Madison (USA). Dept. of Physics). 1974. 13p. Dep. NTIS $4.00.

The existence of transverse polarization of the electron beam in the SPEAR storage ring resulting from the emission of synchrotron radiation in the magnetic field has been observed. The time constant for polarization build-up has been measured for a single circulating electron beam to be 110^+40/sub -30/ min, and the corresponding equilibrium polarization to be 0.85/sub -.25/ /sup +15/. These values are to be compared with the theoretical predictions of 124 min and 0.924, respectively. (auth)

4182 USE OF THE VEPP-3 STORAGE RING SYNCHROTRON RADIATION FOR STUDY ON X-RAY DIFFRACTION. Mokul'skaya, T. D.; Mokul'skii, M. A.; Nikitin, A. A.; Anashin, V. V.; Kulipanov, G. N.; Lukashev, V. A.; Skrinskii, A. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Ehnergii SSSR, Moscow. Inst. Atomnoi Ehnergii. AN SSSR, Novosibirsk. Inst. Yadernoi Fiziki). Dokl. Akad. Nauk SSSR; 218: No. 4, 824-827 (1 Oct 1974). (In Russian).

A report is presented on the first results of using synchrotron radiation from the accumulator ring for x ray studies. The study was performed on the VEPP-3 accumulator at an electron energy of 2 GeV. (tr-SJR)

Experimental Facilities

Refer also to abstracts 3595 and 3627.

4183 PROTOTYPE TESTS ON A 200-W FORCED CONVECTION LIQUID HYDROGEN/DEUTERIUM TARGET. Williamson, K. D.; Simmons, J. E.; Edeskuty, F. J.; Fretwell, J. H.; Martin, J. T.; Ficht, H. (Los Alamos Scientific Lab., NM). pp 241-247 of Advances in Cryogenic Engineering. Vol. 19. Timmerhaus, K. D. (ed.). New York; Plenum Publishing Corporation (1974).

Characteristics of a prototype target designed to operate with a heat input of 100 to 200 W are discussed. Data are presented on the operating characteristics of the unit using liquid H_2 heated by electric heaters and a 25-MeV electron beam with a time structure similar to the LAMPF beam (25 W/cm³ energy deposition). The final target system designed from the data is discussed briefly. (DLC)

4184 STUDIES OF THE MECHANISM OF A GAS JET RECOIL COIL TRANSPORT SYSTEM. Wiesehahn, W. J.; Bischoff, G.; D' Auria, J. M. (Simon Fraser Univ., Burnaby, British Columbia (Canada). Dept. of Chemistry). Nucl. Instrum. Methods; 124: No. 1, 221-233(15 Feb 1975).

A detailed analysis is made of the losses of clusters in a gas jet transport system. The conclusion is drawn that clusters with a radius of between 10^{-5}cm and 2.5×10^{-4}cm give optimum efficiency for transport and deposition. There is evidence from x-ray studies that the transport is selective as to element but that the relative yield does not depend on the concentration of clusters. For small clusters the angle of deposition is found to be very important. A study is made of the transit time for a He/C_2H_4 mixture, but little improvement was obtained. (auth)

4185 A CLEAN EFFECTIVELY COOLED Ti–T TARGET SYSTEM GIVING A HIGH YIELD OF 14 MeV NEUTRONS. Sikkema, C. P.; Steendam, S. P. (Rijksuniversiteit Groningen (Netherlands)). Nucl. Instrum. Methods; 124: No. 1, 161-164 (15 Feb 1975).

A target system has been developed for producing a high yield of 14 MeV neutrons from the T(d,n) reaction in tritium-titanium targets. The target lifetime is increased by using a liquid-nitrogen-cooled vapour trap and an all-metal construction of the target mounting system. The targets are effectively cooled with water flowing directly behind the substratum. The neutron yield dropped to half its initial value after the irradiation with an integrated current of more than 20 C of 300 keV deuterons per cm² target area. With this system, small samples may be placed only about 2 mm from the neutron source. The small over-all dimensions also allow larger samples to be positioned close to the target, and there is only a small amount of neutron-scattering material near the target. (auth)

4186 RESISTANCE OF SOLID HD POLARIZED-PROTON TARGETS TO DAMAGE FROM HIGH-ENERGY PROTON AND ELECTRON BEAMS. Mano, H.; Honig, A. (Syracuse Univ., N. Y. (USA)). Nucl. Instrum. Methods; 124: No. 1, 1-10(15 Feb 1975).

Solid HD samples, suitable for use as polarized proton targets by virtue of their low ortho-H_2 and para-D_2 impurity concentrations and consequently long proton spin-lattice relaxation times, T_1^H, were irradiated in the 10.4 GeV external beam of the Cornell electron synchrotron and in the 28 GeV extracted proton beam of the AGS synchrotron at Brookhaven National Laboratory. No direct beam-induced depolarization of the protons in HD was observed for integrated particle fluxes up to 10^{13}/cm². The proton beam exposure resulted in a spin-lattice relaxation rate, $(T_1^H)^{-1}_{rad}$, of 0.9×10^{-16}s^{-1} per unit integrated flux (i.e. per particle/cm²), and the electron beam exposure led to a value about 30% higher, due mostly to the production of secondaries. The T_1^H recovers nearly to its original long value when the sample is melted and refrozen after irradiation, indicating that the principal contribution to $(T_1^H)^{-1}_{rad}$ comes from radicals such as atomic H or D and not from symmetry species conversion induced by the beams. After irradiation, annealing of the damage centers was observed at 4.2 K and 4.7 K by monitoring $(T_1^H)^{-1}_{rad}$ as a function of time. These experiments support the proposed usage, at temperatures between 1 and 4 K, of pure solid HD with long T_1^H as a metastably highly polarized proton target for high energy physics experiments at particle fluxes up to about 10^7 particles/cm²s. (auth)

4187 A NEW METHOD FOR MEASUREMENT OF PROTON BEAM ENERGIES. Rolfs, C.; Rodney, W. S. (California Inst. of Tech., Pasadena (USA)); Durrance, S.; Winkler, H. (California Univ., Los Angeles (USA)). Nucl. Phys., A; 240: No. 2, 221-234 (17 Mar 1975).

A convenient and precise method of measuring proton beam energies has been developed using the non-resonant direct-capture reaction $^{16}O(p,\gamma)^{17}F$. The method makes use of the resulting γ-rays whose energies lie near the energy of the proton beam and whose intensities vary smoothly with beam energy. These γ-rays can be observed easily for proton energies above 0.8 MeV. A comparison of the energies of these γ-rays with precisely known energies of γ-rays from radioactive sources enables one to measure the beam energy directly at any given value of interest to a precision of the order of 0.4 keV. The method was applied to determine the Q-value of the $^{17}O(p,\gamma)^{18}F$ reaction: $Q = 5606.2 \pm 0.6$ keV. (auth)

4188 AN IMPROVED AND MODULAR HELIUM-JET RECOIL-TRANSPORT SYSTEM FOR THE STUDY OF SHORT-LIVED NUCLEI. Kosanke, K. L.; Edmiston, M. D.; Warner, R. A.; Firestone, R. B.; McHarris, W. C. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.). Nucl. Instrum. Methods; 124: No. 2, 365-374(1 Mar 1975).

An improved, modular helium-jet recoil-transport system for the study of short-lived ($t_{\frac{1}{2}} \lesssim 0.2$ s) nuclei is described. Its target irradiation assembly consists of modular pieces, allowing the interchanging of different target holders, different recoil-thermalizing chambers, etc., for economical and convenient setting up of each experiment. A remote-control degrader package allows rapid control of accelerator beam energies. Improved target-preparation techniques are described, including com-

pacting oxides onto foils with a hydraulic press. Auxiliary equipment such as gas supplies, capillaries, pumping equipment, and a stepping tape drive for the counting chamber are described. Different detector arrays and assemblies are used for different kinds of nuclear spectroscopy, and data are presented for some of these, including γ-ray, γ-γ megachannel (multiparameter) coincidence, and β-delayed proton spectroscopy. (auth)

4189 PRESSURE MODULATION OF A GAS TARGET. Dose, V.; Hett, W.; Schmocker, U.; Windrich, H. (Wuerzburg Univ. (F. R. Germany). Physikalisches Inst.). Nucl. Instrum. Methods; 124: No. 2, 321-324(1 Mar 1975).

A new design for the measurement of reaction signals in atomic-collision work as a function of target density is described. The main features include a novel means for a nearly linear periodic variation of target density as a function of time and a step-up step-down staircase analog-to-digital converter with up to 256 channels which was specially designed for the present application. The system is operated under computer control. Examples are given for application of the system to beam-attenuation measurements as well as to Lyman-α production in thermal-energy H(2s)-H_2 collisions. (auth)

4190 SILICON-NITRIDE TARGET FOR LOW-ENERGY NUCLEAR REACTIONS. Otsubo, T.; Asada, I. (Tokyo Inst. of Tech. (Japan). Dept. of Physics); Shinoki, F. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). Nucl. Instrum. Methods; 124: No. 2, 325-327(1 Mar 1975).

A self-supporting silicon-nitride target foil has been fabricated by a radio-frequency reactive sputtering method. Results of measurements with this target foil show that this method is useful for fabrication of a nitrogen target. (auth)

4191 LINEAR FOCUSSING OF NEUTRINO PARENTS. I. Elliptical Lenses. Dohm, V.; Faissner, H.; Hasert, F. J.; von Krogh, J.; Thome, W. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.). Nucl. Instrum. Methods; 124: No. 2, 477-484(1 Mar 1975).

This paper treats the general problem of focusing charged particles, e.g. neutrino parents, by means of (pulsed) rotationally symmetric current sheets. An exact parametric representation for the particle trajectories is given. The shape of a current sheet is derived which has ideal focusing properties for arbitrary angles. This shape is well approximated by an ellipsoid. The linearity of such an elliptical lens is demonstrated. This lens can be used to focus particles of a wide range of momenta. Elliptical lenses can be combined into lens systems, using the standard methods of geometrical optics. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

4192 THEORETICAL PROBLEMS OF HIGH ENERGY ASTROPHYSICS. Burbidge, G. R. (Univ. of California, San Diego). pp 173-199 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on theoretical problems of high energy astrophysics includes a summary of the four basic cosmic components, intergalactic matter, stars and galaxies, quasi-stellar sources and related peculiar objects, and relativistic particles. (JFP)

4193 EXTRAGALACTIC OBSERVATIONAL ASTRONOMY. Sargent, W. L. W. (California Inst. of Tech., Pasadena). pp 453-518 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on extragalactic observational astronomy includes the redshift controversy, normal galaxies, determination of the Hubble constant using diameters of HII regions, determination of the deceleration parameter, the luminosity–volume test as evidence for the cosmological interpretation of quasars, problems involving clusters and groups of galaxies. (JFP)

4194 THEORY OF PULSARS: POLAR GAPS, SPARKS, AND COHERENT MICROWAVE RADIATION. Ruderman, M.A.; Sutherland, P.G. (Department of Physics, Columbia University). Astrophys. J. 196: No. 1, 51-72 (15 Feb 1975).

The huge magnetic fields characteristic of pulsars cause the nuclei (largely iron) of the stellar surface to form a tightly bound condensed state. Except for the very young Crab pulsar, theory and observation both support the view that the stellar surface is not hot enough to sustain an outflow of positive ions to balance the outflow of electrons as charge leaves the magnetosphere through the light cylinder along the open magnetic field lines. Adopting the conventional assumption that electrons do not return to the neutron star by coming back through the light cylinder along the open field lines, we are led to the following consequences for a neutron star whose magnetic moment tends to be antiparallel (as opposed to parallel) to its spin angular momentum: A polar magnetospheric gap is formed that spans the open field lines from the stellar surface up to an altitude of about 10^4 cm. In the gap $E \cdot B \neq 0$, although it vanishes essentially everywhere else in the near magnetosphere. The potential difference between the base and top of the gap is about 10^{12} volts. The gap continually breaks down (sparking) by forming electron-positron pairs on a time scale of a few microseconds. The gap positrons move out along the open field lines, and electrons flow to the stellar surface to close the pulsars's homopolar generator circuit as in the related Sturrock model. We show how this can lead to injection into the near magnetosphere of ultrarelativistic positrons and the pairs subsequently produced by curvature radiation from the positrons leads to coherent microwave radiation in the frequency range and with remarkably many of the characteristics observed in pulsars. The properties and energetics of the sparking in the gap lead directly to (i) the maximum total luminosity of the pulsar and its dependence on period P: $L_{max} \approx 10^{30} P^{-15/7}$ ergs s^{-1}, (ii) the observed drifting of subpulses and quantitative expressions for P_2 and P_3 (assuming that the sparking is localized, rapidly fluctuating but only rarely self-quenching), (iii) microstructures of pulses, (iv) the turnoff of a pulsar as its period increases, and (v) apparent weakening of the magnetic field in older pulsars. The production of coherent microwave radiation in the near magnetosphere results in substantial qualitative agreement with observations in these areas: (i) shapes and widths of pulse envelopes, (ii) their period and frequency dependence, and (iii) the sweep of linear polarization through the pulse envelope. (auth)

Cosmic Radiation

Refer also to abstracts 3603 and 4533.

4195 GALACTIC WINDS DRIVEN BY COSMIC RAYS. Ipavich, F.M. (Department of Physics and Astronomy, University of Maryland, College Park). Astrophys. J. 196: No. 1, 107-120 (15 Feb 1975).

Cosmic rays traveling through a magnetized plasma with mean velocity greater than the Alfvén speed can become coupled to the plasma by the emission of magnetohydrodynamic waves. Using a time-independent, spherically symmetric, hydrodynamic treatment, we show that cosmic rays escaping from a galaxy can carry along thermal gas and produce a "galactic wind." Solutions indicate that a typical galaxy can lose mass at a rate $\sim 1\text{–}10\, M_\odot\ \mathrm{yr}^{-1}$ and energy at a rate $\approx 10^{40} - 10^{42}$ ergs $^{-1}$. The possible role of galactic winds in radio and X-ray sources is explored. A model is proposed to explain the X-ray emission observed from clusters of galaxies. (auth)

4196 A SEARCH FOR VHF RADIO PULSES IN COINCIDENCE WITH CELESTIAL GAMMA-RAY BURSTS. Baird, G.A.; Delaney, T.J.; Lawless, B.G. (Physics Department, University College Dublin); Griffiths, D.J.; Shakeshaft, J.R.; Drever, R.W.P.; Meikle, W.P.S.; Jelley, J.V.; Charman, W.N.; Spencer, R.E. Astrophys. J. Lett. 196: No. 1, L11-L13 (15 Feb 1975).

A detailed search for coincident pulses has been made of VHF radio recordings taken at widely spaced stations around the times of 19 celestial γ-ray bursts between 1970 and 1973. No coincident pulses were found above a sensitivity level of the order of 10^{-12} ergs cm^{-2} (event)$^{-1}$ in a 1-MHz bandwidth. (auth)

4197 OBSERVATIONS OF COSMIC GAMMA-RAY BURSTS WITH IMP-7: EVIDENCE FOR A SINGLE SPECTRUM. Cline, T.L.; Desai, U.D. (NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771). Astrophys. J. Lett. 196: No. 1, L43-L46 (15 Feb 1975).

Spectral observations of nine recent cosmic γ-ray bursts are reported. The average photon number spectra of all nine events are each consistent with a 150-keV exponential from 100 keV to about 400 keV, and a power law of index −2.5 from 400 keV to 1100 keV. The observations also indicate an event rate of 16 in 1972 and 1973, or 8 ± 2 per year, higher than the 5 ± 1 per year initially reported. This corresponds to an approximately 40 percent lower effective intensity threshold, attained by using more sensitive detectors in multiple-satellite coincidence. (auth)

4198 GALACTIC POSITRONS AND γ-RAYS, AND THE COSMIC-RAY MEAN PATH-LENGTH IN THE GALAXY. Dilworth, C. (Cambridge Univ. (UK). Inst. of Theoretical Astronomy); Maraschi, L.; Perola, G. C. (Milan Univ. (Italy). Istituto di Scienze Fisiche; Consiglio Nazionale delle Ricerche, Milan (Italy). Lab. di Fisica Cosmica e Tecnologie Relative). Astron. Astrophys.; 33: No. 1, 43-48 (Jun 1974).

The interstellar equilibrium spectrum of cosmic-ray positrons arising from meson decay is calculated with two propagation models [(a) slow leakage from the galactic disk, and (b) isotropic diffusion] using the information on the cosmic ray distribution in the Galaxy obtained from an analysis of the γ-ray data. Comparison with the experimental information on the interstellar positron flux suggests that in model (a) the mean path length should be energy or rigidity dependent with a value of 2 g/cm^2 at 1 GeV (for positrons). In the model of isotropic diffusion out to distances of the order of the galactic radius no dependence of the mean path length on energy is required from the positron data. The results are discussed in relation with those obtained from the data on the fragmentation of the nucleonic component. (auth)

4199 SPATIAL AND SPECTRAL ANOMALIES IN THE SOFT X-RAY BACKGROUND. de Korte, P. A. J. Leiden; Rijksuniversiteit Leiden (1975). 96p.

Thesis.

The results of two rocket-borne observations which were shown to be free of major ambiguities arising from uv-radiation and low-energy electrons are reported. Two different entrance windows were used, which provides the means to determine the spectral distribution of the cosmic soft x-ray background with a better energy resolution than attainable with the proportional counters themselves. X-ray sky maps covering about 50% of the total sky are presented, and from these it is seen that a large part of the soft x-ray background is probably of galactic origin, and that there are associations between certain x-ray features and the Cetus Arc and Loop IV, and faint Hα-nebulosities. (NL)

4200 DECAYING NUCLEI AND THE AGE OF COSMIC RAYS IN THE GALAXY. Prishchep, V. L.; Ptuskin, V. S. (AN SSSR, Moscow. Fizicheskij Inst.). Astrophys. Space Sci.; 32: No. 2, 265-271 (Feb 1975).

The propagation of radioactive nuclei of cosmic rays in a flat diffusion galactic model (sources and the main gaseous mass are concentrated in the galactic disc) is considered. The corresponding results are not reducible to the results of a simple homogeneous model. It is shown that the recent data on the ^{10}Be nuclei abundance in cosmic rays do not contradict the occurrence of a large cosmic-ray halo. (auth)

4201 COSMIC NEUTRINOS OF ULTRA-HIGH ENERGIES AND DETECTION POSSIBILITY. Berezinskii, V. S.; Smirnow, A. Yu. (AN SSSR, Moscow. Inst. Yadernykh Issledovanij). Astrophys. Space Sci.; 32: No. 2, 461-482(Feb 1975).

The fluxes and spectra of galactic and extragalactic neutrinos at energy 10^{11} to 10^{19} eV are calculated. In particular, the neutrino flux from the normal galaxies is calculated taking into account the spectral index distribution. The only assumption that seriously affects the calculated neutrino flux at $E_\nu > 10^{17}$ eV is the power-like generation spectrum of protons in the entire considered energy region. The normal galaxies with the accepted parameters generate the metagalactic equivalent electron component (electrons + their radiation) with energy density $\omega_e \sim 8.5 \times 10^{-17}$ eV cm^{-3}, while the density of the observed diffuse x-ray radiation alone is 100 times higher. This requires the existence of other neutrino sources and we found the minimized neutrino flux under two limitations: (1) the power-law generation spectrum of protons and (2) production of the observed energy density of the diffuse x and γ radiation. These requirements are met in the evolutionary model of origin of the metagalactic cosmic rays with modern energy density $\omega_{Mg} \sim 3.6 \times 10^{-3}$ eV cm^{-3}. The possibility of experiments with cosmic neutrinos of energy $E_\nu \sim 3 \times 10^{17}$ eV is discussed. The upper bound on neutrino–nucleon cross section $\sigma < 2.2 \times 10^{-29}$ cm^2 is obtained in evolutionary model from the observed zenith angular distribution of extensive air showers. The diffuse x- and γ-ray flux arising together with neutrino flux is calculated. It agrees with observed flux in the entire energy range from 1 keV up to 100 MeV. (auth)

4202 $^{14}C-^{39}Ar_{Me}$ CORRELATIONS IN CHONDRITES AND THEIR PRE-ATMOSPHERIC SIZE. Born, W.; Begemann, F. (Max-Planck-Institut fuer Chemie (Otto-Hahn-Inst.), Mainz (F. R. Germany). Kernphysikalische Abt.). Earth Planet. Sci. Lett.; 25: No. 2, 159-169(Mar 1975).

Cosmogenic ^{14}C has been measured in 12 chondrites and the stone phase of the mesosiderite Bondoc. For the chondrites analyzed the activities vary between 44 and 72 dpm/kg; the low value of (4.5 ± 0.9) dpm/kg for Bondoc is essentially due to its large pre-atmospheric size and not to a terrestrial age of several half-lives of ^{14}C. In eight cases ^{39}Ar in the metal phase from the same meteorite specimens had been measured previously. The results are combined to derive the pre-atmospheric radii R_0 of the meteoroids and depth of burial of the samples investigated. Values of R_0 between 35 and 82 cm are obtained; of 14 samples ten came from a depth of 10 cm or less. The preponderance of samples from shallow depths is ascribed to asymmetrical ablation losses of the meteoroids during their passage through the atmosphere. A compilation of all published ^{14}C concentrations in chondrites shows that the variations between different specimens from the same meteorites are almost as large as those for samples from different meteorites. Thus, there is no need to invoke different orbits of the meteoroids and a strong spatial gradient in the primary cosmic-ray intensity to explain variations of low-energy-produced cosmogenic nuclides in different meteorites. (auth)

Stars

Refer also to abstracts 4824 and 5089.

4203 (JINR–D3-7991, pp 139-156) PROPERTIES OF THE MATTER OF NEUTRON STARS. Bisnovatyi-Kogan, G. S. (Inst. of Applied Mathematics, Moscow). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

By convention neutron stars can be divided into four zones: the outer plasma zone, the zone of variable nuclear composition and crystalline crust, the zone of nuclear matter existing either in liquid or solid form, and the zone of hyperon nuclei. Each of these is discussed, and the evolutionary approach to the determination of the nuclear composition in the shell of the neutron star is considered. The effects of a strong magnetic field on the properties of these four zones are analyzed. (3 figures) (JSR)

4204 PHOTOELECTRIC PHOTOMETRY OF RW GEMINORUM. Tremko, J. (Astronomical Inst., Skalnate Pleso, Czech.); Vetesnik, M. Bull. Astron. Inst. Czech.; 25: No. 6, 331-336(1974).

On the basis of 4510 photoelectric observations obtained at the Skalnaté Pleso Observatory in V color the investigation of the eclipsing variable RW Gem was carried out. Six new epochs of minimum light are obtained and new orbital solution is derived. The observed light anomalies of the light curve could be explained by the mass exchange in the system. The linear limb darkening coefficients computed for both components are discussed. (auth)

4205 MODEL ATMOSPHERE ANALYSIS OF THE PECULIAR STAR 53 AUR. II. Method and Application. Zverko, J. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 25: No. 6, 321-330(1974).

The method of weighting and saturation functions is applied to determination of abundances. Theoretical curves of growth were computed for 108 lines of 21 elements and three atmospheric models. Abundance anomalies of the Mn-type were determined for 53 Aur. A surface concentration and some non-LTE effects are possible. (auth)

4206 QSO'S, OBSERVATIONS, AND THE REDSHIFT PROBLEM. Arp, H. C. (California Inst. of Tech., Pasadena). pp 1-76 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on quasi-stellar objects observations and the redshift problem include the ejection of matter from galaxies, redshift anomalies of large galaxies and their companions, observational differences between south and north galactic hemispheres, and an atlas of peculiar galaxies. (JFP)

4207 X-RAY ASTRONOMY. Giacconi, R. (Harvard Coll. Observatory, Cambridge, MA). pp 201-253 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

Review lectures are given on what is known about x-ray emission from celestial objects. The main concern is with a general review of aspects of galactic and extragalactic sources. (JFP)

4208 THERMONUCLEAR ASTROPHYSICS. Clayton, D.D.; Woosley, S.E. (Department of Space Physics and Astronomy, Rice University, Houston, Texas 77001). Rev. Mod. Phys. 46: No. 4, 755-771 (Oct 1974).

We discuss the types of thermonuclear reactions that are of importance to stellar evolution and nucleosynthesis, with particular attention to the explosive ejection of shells of He, C, O, and Si. We present tables of the reactions important in the various burning phases, including the reason for their importance and an estimate of the value of a carefully measured rate. This format is chosen for dual purpose: (1) to clarify the nuclear needs by evaluating the importance of specific reactions within the astronomical settings and (2) by assigning a value scale for cross–section measurements. (auth)

4209 OBSERVATIONS OF LARGE-AMPLITUDE RED VARIABLES. Eggen, O.J. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, The Australian National University). Astrophys. J. Suppl. Ser. 29: No. 276, 77-86 (Feb 1975).

The (UBVRI) observations of large-amplitude red variables presented in this Supplement are discussed in the Journal. (auth)

4210 PERTURBATION OF A SLOWLY ROTATING BLACK HOLE BY A STATIONARY AXISYMMETRIC RING OF MATTER. II. PENROSE PROCESSES, CIRCULAR ORBITS, AND DIFFERENTIAL MASS FORMULAE. Will, C.M. (University of Chicago). Astrophys. J. 196: No. 1, 41-49 (15 Feb 1975).

We present a detailed description of the phenomenon of energy extraction ("Penrose") from a slowly rotating black hole perturbed by a stationary axisymmetric ring of matter, and show that the gravitational interaction between the ring and the particles used in the Penrose process must be taken into account. For the case of a black-hole-ring configuration of "minimum enregy" we show that a Penrose process can extract *further* energy, but that by means of their gravitational forces, the particles used in the process cause the radius of the ring to change, releasing precisely sufficient gravitational potential energy to make up for that extracted. By analyzing the properties of circular test-particle orbits in black-hole-ring spacetimes, we show quantitatively how this change in radius is produced. A "differential mass formula" relating the total masses of neighboring black-hole-ring configurations is also derived. (auth)

4211 SEARCH FOR HIGH-FREQUENCY OPTICAL VARIATIONS IN THE SUPERNOVA 1972e. Miller, R.H.; Lasker, B.M.; Hesser, J.E.; Bracker, S.B. (Cerro Tololo Inter-American Observatory). Astrophys. J. 196: No. 1, 121-123 (15 Feb 1975).

A search for pulsar-like optical variations in the light of the supernova 1972E near NGC 5253 was conducted with null results as follows: No periodic variations within the frequency range 1/8 to 500 Hz were observable to a limit of 1 percent of the brightness of the supernova, and no aperiodic variability was detectable with a limit of about 2–4 percent over the same frequency interval. (auth)

4212 THE PECULIAR OBJECT HD 44179 ("THE RED RECTANGLE"). Cohen, M. (Berkeley Astronomy Department, University of California, Berkeley); Anderson, C.M.; Cowley, A.; Coyne, G.V.; Fawley, W.M.; Gull, T.R.; Harlan, E.A.; Herbig, G.H.; Holden, F.; Hudson, H.S.; Jakoubek, R.O.; Johnson, H.M.; Merrill, K.M.; Schiffer, F.H. III; Soifer, B.T.; Zuckerman, B. Astrophys. J. 196: No. 1, 179-189 (15 Feb 1975).

A strong infrared source detected in the AFCRL sky survey is confirmed, and is identified with the binary star HD 44179, embedded in a peculiar nebula. *UBVRI* and broad-band photometry between 2.2 and 27 μ are combined with blue, red, and near-infrared spectra, polarimetry and spectrophotometry of the star, and a range of direct and image-tube photographs of the nebula, to suggest a composite model of the system. In this model, the infrared radiation derives from thermal emission by dust grains contained in a disklike geometry about the central object, which appears to be of spectral type B9–AO III and which may be in pre-main-sequence evolution. Two infrared emission features are found, peaking at 8.7 and 11.3 μ, the latter corresponding to the feature seen in the spectrum of the planetary nebula NGC 7027. The complex nebular structure is discussed on the basis of photographs through narrow-band continuum and emission-line filters. The polarization data support the suggestion of a disk containing some large particles. No radio continuum emission is detected. (auth)

4213 SPECTROSCOPIC STUDIES OF VERY OLD HOT STARS. I. NGC 246 AND ITS EXCITING STAR. Heap, S.R. (Laboratory for Optical Astronomy, NASA–Goddard Space Flight Center). Astrophys. J. 196: No. 1, 195-204 (15 Feb 1975).

A spectroscopic study has been made of the planetary nebula NGC 246 and its exciting star. Observations of the central star obtained by L. H. Aller at the Lick Observatory indicate that the star has one of the most highly excited spectra known to optical astronomers. The only lines definitely present in the stellar spectrum are lines of C IV and O VI, although lines of He II are probably present. Nitrogen lines, in any ionization state, are absent. The stellar spectrum, therefore, suggests that the triple-α process has operated in this star. Nebular observations obtained at the Laboratory for Optical Astronomy 36-inch (91 cm) telescope were used to estimate the atmospheric properties of the exciting star via the Zanstra method, with results that are in accord with the spectral appearance of the star. This procedure yielded the following probable values for the stellar parameters: $T_{\rm eff} \sim 200{,}000\,^{\circ}$K, $\log g \sim 6.8$, and $R/R_{\odot} \sim 0.05$. Comparison of the properties of the star and surrounding nebula with Paczynski's evolutionary tracks for planetary nuclei suggests that the star is very near the point of exhaustion of its nuclear fuels. (auth)

4214 WAVELENGTH DEPENDENCE OF INTERSTELLAR POLARIZATION AND RATIO OF TOTAL TO SELECTIVE EXTINCTION. Serkowski, K.; Mathewson, D.S.; Ford, V.L. (Mount Stromlo and Siding Spring Observatories, Research School of Physical Sciences, Australian National University). Astrophys. J. 196: No. 1, 261-290 (15 Feb 1975).

Wavelength dependence of interstellar linear polarization has been observed for about 180 stars, mostly southern, in the *UBVR* spectral regions. A multichannel polarimeter-photometer, in which spectral regions are separated by dichroic filters, was used. Normalized wavelength dependence of interstellar linear polarization p follows closely a single empirical curve $p(\lambda)/p_{\max} = \exp[-1.15 \ln^2(\lambda_{\max}/\lambda)]$, where the wavelength $\lambda_{\max}$ at which the maximum interstellar linear polarization $p_{\max}$ occurs takes values from 0.45 μ to 0.8 μ. Wavelength $\lambda_{\max}$ is well correlated with the ratios of color excesses E_{V-K}/E_{B-V}, E_{V-K}/E_{V-R}, and E_{V-I}/E_{V-R}. These correlations indicate that the ratio R of total to selective interstellar extinction can be found for any individual star from the relationship $R = 5.5\,\lambda_{\max}$. Polarimetry seems to be the most practical method of estimating R. A map of distribution of $\lambda_{\max}$ on the sky, based on values for about 350 stars, indicates several well defined regions with $\lambda_{\max}$, and hence R, clearly larger (or smaller) than the median value $\lambda_{\max} = 0.545$ μ, corresponding to $R = 3.0$. The predominance of larger than average values of $\lambda_{\max}$ among stars nearer than 0.4 kpc and the negative correlation between $\lambda_{\max}$ and E_{B-V} are explained by selection effects. There is evidence of negative correlation between $\lambda_{\max}$ and $p_{\max}/E_{B-V}$ suggested by Kruszewski. The lower limits for color excess of Praesepe, M67, and several globular clusters are set by their linear polarization. The largest known values of interstellar circular polarization, $|q| \simeq 0.06$ percent, were found in near-infrared for two stars with exceptionally small $\lambda_{\max}$: star No. 12 in association VI Cygni and HD 204827. (auth)

4215 THE BROADENING OF CALCIUM II H AND K LINES BY HELIUM. Hammond, G.L. (Naval Ordnance Laboratory, Silver Spring, Maryland). Astrophys. J. 196: No. 1, 291-305 (15 Feb 1975).

Laboratory measurements of widths and shifts of the Ca II H and K lines have been made under conditions simulating those in the atmospheres of metallic-line white dwarfs, namely, densities of 10^{21} helium atoms cm^{-3} and temperatures of 4500° to 6000°K. There are significant differences in the shifts and damping constants of the two fine-structure components. The impact theory is evidently applicable to the Ca II /He system under these conditions, and the observed damping constants are fortuitously close to the predictions of conventional Lindholm-Foley/van der Waals theory. The widths and shifts have also been analyzed in terms of Lennard-Jones potential theory. (auth)

4216 RADIATIVE LIFETIMES FOR THE $A^1\Pi$ AND $B^1\Delta$ STATES OF THE CH^+ MOLECULE WITH APPLICATION TO THE CH^+ ABUNDANCE IN ZETA OPHIUCHI. Brooks, N.H.; Smith, W.H. (Princeton University Observatory). Astrophys. J. 196: No. 1, 307-310 (15 Feb 1975).

Using an electron-beam phase-shift apparatus, we have measured radiative lifetimes of 270±75 ns and 290±75 ns, respectively, for $v=1$ and 2 levels of the $A^1\Pi$ state of the CH^+ molecule, and lifetimes of 180±50 ns and 165±50 ns for the $v=0$ and 1 levels, respectively, of the $B^1\Delta$ state of CH^+. We find relatively poor agreement with lifetimes calculated from the theoretical transition moment of Yoshimine *et al.* where lifetimes of 840 and 885 ns are predicted for the $v=1$ and 2 levels of the A^1 II state. Closer, but still unsatisfactory, agreement is found with the lifetimes of 495 ± 50 ns and 530 ± 50 ns found experimentally for $v' = 1$ and 2 of the A^1 II state by Brzozowski *et al.* Although this range of values is still undesirably large, and the origin of the discrepancies obscure, an f_{0-0} of 0.014 ± 0.003 is recommended from the data. This f-value represents a considerable improvement in the reliability of the oscillator strength, and concomitantly in column densities from observations and the radiative recombination rates calculated from theory. (auth)

4217 IDENTIFICATION OF G227–35 AS A STRONGLY POLARIZED MAGNETIC WHITE DWARF. Angel, J.R.P.; Hintzen, P. (Steward Observatory); Landstreet, J.D. Astrophys. J. Lett. 196: No. 1, L27-L29 (15 Feb 1975).

G227-35, a white dwarf suspect with high proper motion from the Lowell survey, is found to be a magnetic white dwarf with no detectable absorption features. The circular polarization spectrum has been measured both with broad-band filters and at 160 to 360 Å resolution. It shows a maximum of 3.3 percent at ∼4500 Å, and is increasing again strongly in the infrared, reaching ∼8 percent at 1 μ. No variability was detected over a 5-month period, and no linear component of polarization is found. (auth)

4218 VERY LONG BASELINE INTERFEROMETRIC OBSERVATIONS OF OH/IR STARS. Reid, M.J.; Muhleman, D.O. (Owens Valley Radio Observatory and Division of Geological and Planetary Sciences, California Institute of Technology). Astrophys. J. Lett. 196: No. 1, L35-L37 (15 Feb 1975).

Very long baseline interferometric observations of five type II OH/IR objects indicate that the apparent size of the masing components is greater than ∼0".1. The present observations, combined with current theories, indicate that the 1612-MHz OH maser associated with Mira variables originates in the outer regions of the circumstellar dust. (auth)

4219 A COMPARISON OF GALACTIC AND LARGE MAGELLANIC CLOUD G—TYPE SUPERGIANTS BY A METHOD OF SPECTRUM SYNTHESIS. Fry, M.A.; Aller, L.H. (Department of Astronomy, University of California, Los Angeles). Astrophys. J. Suppl. Ser. 29: No. 275, 55-75 (Jan 1975).

The spectra of two G4 Ia supergiants–HR 8752 and R59, in the Perseus spiral arm and Large Magellanic Cloud, respectively—are analyzed by a method of spectrum synthesis, heretofore applied mostly to the Sun. Evidence is presented that both of these stars are reddened by local dust clouds. Consequently, selection of appropriate model atmospheres must depend heavily on line spectrum data. A self-consistent spectrum synthesis analysis suggests that, to within a scatter of ± 0.4 in log A among individual elements, these stars are similar in composition to the Sun, although there is evidence that metals are definitely underabundant in the LMC star as compared with the Sun. (auth)

4220 UNIQUENESS OF THE KERR BLACK HOLE. Robinson, D.C. (Department of Mathematics, King's College, Strand, London WC2, United Kingdom). Phys. Rev. Lett. 34: No. 14, 905-906 (7 Apr 1975).

The family of Kerr solutions, with $|a| < m$, is shown to be the unique pseudostationary family of black-hole solutions of the Einstein vacuum field equations when the event horizon is assumed to be nondegenerate. (auth)

4221 STUDY OF THE MOTION, MEMBERSHIP, AND DISTANCE OF THE HYADES CLUSTER. Hanson, R.B. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz, California). Astron. J. 80: No. 5, 379-401 (May 1975).

New absolute proper motions referred directly to external galaxies, photographic photometry, and cluster membership probabilities have been determined for over 600 faint stars in the Hyades region. These have been used to investigate the Hyades convergent point and distance. A detailed review of the foundations of the convergent-point method, its applicability to the Hyades, the several mathematical variations of the method, and its possible role in producing the apparent discrepancy

between previous Hyades proper motion results and "secondary" Hyades distance indicators, has been carried out. The convergent-point method, as applied to the Hyades, is entirely valid, and cannot be the source of any significant error in the Hyades distance. Systematic errors in meridian circle proper motions are implicated as the cause of the observed Hyades distance discrepancy. The convergent-point analysis of the new absolute Hyades proper motions represents the first Hyades distance determination *independent* of all meridian circle proper motion systems. The resulting Hyades distance modulus is $m-M = 3.42 \pm {}^{0.21}_{0.19}$, significantly greater than all previous values from proper motions, and in agreement with predictions of the Hyades distance from stellar structure theory, and with the results of "secondary" distance indicators. Incorporating this value, the most likely value of the mean Hyades distance modulus from all sources is $m-M = 3.29 \pm 0.08$. The quoted error represents a larger and more realistic estimate of the true errors than has been previously stated. Significant effects of the increased Hyades distance on the cosmic distance scale and other questions of general astronomical importance are briefly discussed. (auth)

4222 INTERFERENCE FRINGES OBTAINED ON VEGA WITH TWO OPTICAL TELESCOPES. Labeyrie, A. (Observatoire de Paris, 92190-Meudon, France). Astrophys. J. Lett. 196: No. 2, L71-L75 (1 Mar 1975).

Two small telescopes spaced by 12 m have been operated as a Michelson stellar interferometer. The system may be expanded progressively into a telescope array. Plans are made for starting a multinational array with a pair of 1.5-*m* telescopes. (auth)

4223 EVIDENCE FOR X—RAY EMISSION FROM CAPELLA. Catura, R.C.; Acton, L.W.; Johnson, H.M. (Lockheed Palo Alto Research Laboratory). Astrophys. J. Lett. 196: No. 2, L47-L49 (1 Mar 1975).

X-ray emission in the range from 0.2 to 1.6 keV has been detected from an area of the sky which contains the binary star system Capella. The X-ray source is at most a few arc minutes in extent and shows no spectral turnover at low energy, consistent with a nearby source. We suggest Capella as the source of this emission and that this object belongs to a new class of galactic X-ray sources with a luminosity of $10^{31}-10^{34}$ ergs s^{-1}. Emission from this class of objects is variable, predominantly below 2 keV, and originates from nearby stellar objects. (auth)

4224 THE PERIOD AND LIGHT CURVE OF THE 71-SECOND VARIATION IN DQ HERCULIS. Nelson, M.R. (Department of Astronomy and Department of Physics, University of Illinois, Urbana). Astrophys. J. Lett. 196: No. 3, L113-L116 (15 Mar 1975).

The 71^s signal in the old nova DQ Herculis has been observed during the 1974 season. The period at the present epoch allows more accurate estimates of the secular decrease in period. The period decrease appears to be nonlinear. Evidence is also presented to show that the true period of the signal is 142^s. (auth)

4225 A FURTHER LIST OF DEGENERATE STARS. VIII. Greenstein, J.L. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. Lett. 196: No. 3, L117-L120 (15 Mar 1975).

A statistical survey of proper-motion stars with the multichannel spectrophotometer yields 44 further degenerate stars. A considerable number are cool; two composite stars are found, as well as a double white dwarf. Use of the University College, London, digital spectrograph reveals some interesting features visible only at its higher resolution, notably a hot, metallic-line degenerate (Gr 346); and several suspected red degenerates proved to be weak-lined sub-dwarfs. (auth)

4226 THE UPPER MASS LIMIT FOR WHITE DWARF FORMATION AS DERIVED FROM THE STELLAR CONTENT OF THE HYADES CLUSTER. van den Heuvel, E.P.J. (Institute for Advanced Study, Princeton, New Jersey). Astrophys. J. Lett. 196: No. 3, L121-L123 (15 Mar 1975).

The observed number of white dwarfs in the Hyades cluster (between 11 and 14) sets an upper limit m_* smaller than $6\,M_\odot$ (and almost certainly smaller than $5\,M_\odot$) to the masses of stars which finish life as white dwarfs. This result is obtained using the total number of cluster stars brighter than $m_v = 8.4$, together with a turnoff mass of $2.0 \pm 0.3\,M_\odot$, as obtained from the fitting of theoretical timelines to the upper part of the cluster main sequence. The most likely value for m_* thus derived is 3–$4\,M_\odot$. This limit is of importance for questions regarding carbon detonation and pulsar formation. If all stars more massive than $4\,M_\odot$ leave remnants, at least some 10 to 20 Hyades stars must have evolved into neutron stars or black holes. (auth)

4227 THE Mg II DOUBLET EMISSIONS NEAR 2800 Å OBSERVED IN ALPHA TAURI, ALPHA ORIONIS, AND EPSILON PEGASI. Kondo, Y.; Morgan, T.H. (NASA Johnson Space Center, Houston, Texas); Modisette, J.L. Astrophys. J. Lett. 196: No. 3, L125-L128 (15 Mar 1975).

The Mg II doublet emissions at 2795 and 2802 Å were observed in α Tau (K5 III), ε Peg (K2 Ib), and α Ori (M2 Iab). The equivalent-width versus absolute-magnitude relation discussed earlier by Kondo *et al.* has been updated using these observations and recent observations of α Boo by Moos *et al.* The asymmetry in the 2795 Å emission together with the 2802 A component may be an indicator of a cooler shell surrounding supergiants. (auth)

4228 HIGH EFFICIENCY OF THE PENROSE MECHANISM FOR PARTICLE COLLISIONS. Piran, T.; Shaham, J.; Katz, J. (Racah Institute of Physics, The Hebrew University, Jerusalem, Israel). Astrophys. J. Lett. 196: No. 3, L107-L108 (15 Mar 1975).

It is shown that, by two-particle collisions, rather than particle disintegration, one substantially increases the efficiency of the Penrose mechanism. The process may be relevant when considering both means of extracting energy from black holes and means of producing energetic particles. The process can be operating in close binary systems, such as some compact X-ray sources, of which one of the members is a black hole. (auth)

4229 SLOWLY ROTATING RELATIVISTIC STARS. VIII. FREQUENCIES OF THE QUASI-RADIAL MODES OF AN $n=3/2$ POLYTROPE. Hartle, J.B. (Department of Physics, Yale University); Friedman, J.L. Astrophys. J. 196: No. 2, 653-660 (1 Mar 1975).

The expressions derived by Hartle, Thorne, and Chitre and by Chandrasekhar and Friedman for the change in frequency of a radial mode of a spherical star induced by a slow and rigid rotation are applied to the lowest modes of stars constructed from a $n=3/2$ relativistic polytropic equation of state corresponding to an ideal nonrelativistic free neutron gas. The two expressions give identical results. (auth)

4230 ON THE COLLAPSE OF IRON STELLAR CORES. Barkat, Z.; Rakavy, G.; Reiss, Y. (Hebrew University of Jerusalem, Israel); Wilson, J.R. Astrophys. J. 196: No. 2, 633-638 (1 Mar 1975).

The collapse of iron stellar cores is investigated to see whether the outward shock produced by the bounce at neutron star density is sufficient to burn appreciable amounts of the envelope around the iron core. Several models were tried, and in all cases no appreciable burn took place; hence no explosion results from the collapse of these models. (auth)

4231 A REALISTIC LOWER BOUND FOR THE MAXIMUM MASS OF NEUTRON STARS. Bowers, R.L. (Department of Astronomy); Pedigo, R.D.; Gleeson, A.M.; Zimmerman, R.L. Astrophys. J. 196: No. 2, 639-645 (1 Mar 1975).

An equation of state for neutron matter which includes relativistic pion exchange is used to calculate neutron star masses and moments of inertia. The equation of state sets a reasonable *lower* bound on the softness of cold superdense matter, and leads to a maximum equilibrium neutron star mass of $0.52\,M_\odot$. Processes which could affect our conclusions, such as hyperonization, nonnormal ground states, solidification and local anisotropy are discussed. (auth)

4232 IMPROVED OPACITY CALCULATIONS. Magee, N.H. Jr.; Merts, A.L.; Huebner, F.W. (University of California, Los Alamos Scientific Laboratory). Astrophys. J. 196: No. 2, 617-620 (1 Mar 1975).

Inclusion of new atomic data and improvements in the numerical procedure of opacity calculations as well as the increased iron abundance have led to significant increases from previously published astrophysical tables. This increase is at least 50 percent over sizable ranges of temperature and density. The new opacities for Iben XIV mixture with increased iron are presented. The treatment of narrow lines is given as an example of the type of improvements to numerical procedures. The effect of the improvements to other astrophysical mixtures is discussed. (auth)

4233 ROTATING MAGNETOSPHERES: FROZEN-IN-FLUX VIOLATION. Michel, F.C. (Department of Space Physics and Astronomy, Rice University). Astrophys. J. 196: No. 2, 579-582 (1 Mar 1975).

We show that previous solutions for the distant magnetic field structure about a rotating axisymmetrically (dipole) magnetized object are internally inconsistent. It appears necessary to allow for an effective (nonuniform) rotation rate $\omega(f)$ which differs from that of the star itself and which varies with magnetic latitude. As a result, the frozen-in-flux-approximation must fail somewhere in the system. With this modification, the resultant equations seem self-consistent. Previous results are further generalized, with the field lines spiraling according to $\tan \xi = \omega(f)\,\rho/c$, where ρ is the axial distance, and for the (massless) plasma velocities, the radial velocity approaches c and the azimuthal velocity falls inversely with axial distance. (auth)

4234 MODELS FOR X—RAY ILLUMINATED ATMOSPHERES. Milgrom, M.; Salpeter, E.E. (Center for Radiophysics and Space Research, Cornell University). Astrophys. J. 196: No. 2, 583-588 (1 Mar 1975).

A numerical scheme has been developed to study plane-parallel stellar atmospheres, with a given surface temperature and gravity, illuminated by a beam of X-rays. For given total flux, spectrum, and angle of incidence of the X-ray beam, the structure of the atmosphere and the

characteristics of the outgoing radiation are calculated. The scheme is applicable to binary systems in which one member is a compact X-ray source and the other is a normal star. The results are presented for a few models with different values of the input parameters. (auth)

4235 CALCULATION OF THE LIGHT CURVES OF HZ HERCULIS. Milgrom, M.; Salpeter, E.E. (Center for Radiophysics and Space Research, Cornell University). Astrophys. J. 196: No. 2, 589-592 (1 Mar 1975).

The consequences are tested of the assumption that HZ Herculis is exposed to X-ray illumination from Her X-1, with intensity extrapolated from the X-rays observed terrestrially during the peak of the 35-day cycle. Further assumptions are that HZ Her fills its Roche lobe and that we are practically in the orbital plane. We compute the magnitude of HZ Her, at different wavelengths, as a function of the orbital phase. The computed excess luminosity, caused by the X-ray heating, agrees very well with the observed value, and so does the wavelength dependence of this quantity. The scheme adopted cannot reproduce the sharp minimum in the light curve. We also provide some results for the structure of the X-ray affected atmosphere. (auth)

4236 M78: AN ACTIVE REGION OF STAR FORMATION IN THE DARK CLOUD LYNDS 1630. Strom, K.M.; Strom, S.E. (Kitt Peak National Observatory); Carrasco, L.; Vrba, F.J. Astrophys. J. 196: No. 2, 489-501 (1 Mar 1975).

Several luminous stars in the dark cloud (L1630) containing M78 (NGC 2068) are found to have ages as young as a few times 10^5 years. The properties of the stellar population apparently associated with this dark cloud are investigated; it appears that star formation has taken place over a period of several million years. A significant number of heavily obscured ($A_v \gtrsim 10$ mag) stars has been found in the course of a 2-μ survey of selected regions in the L1630 cloud complex. These objects appear best interpreted as stars of late B and early A spectral type embedded within the dense cloud material. The ratio of total to selective extinction is anomalously low in this dense cloud complex. (auth)

4237 THE BALMER DISCONTINUITIES OF O9–B2 SUPERGIANTS. Schild, R.E.; Chaffee, F.H. (Center for Astrophysics, Harvard College Observatory). Astrophys. J. 196: No. 2, 503-513 (1 Mar 1975).

New energy distributions of supergiants at 50 Å resolution from λλ3200–8000 show that the Balmer discontinuities are poorly correlated with spectral types. A particularly good example is ϵ Ori, whose Balmer discontinuity is 0.1 mag larger than other O9.5 Ia and B0.5 Ia supergiants. Analysis of available four-color and Hβ photometry shows that whereas Hβ correlates well with luminosity as indicated by MK luminosity class, the Balmer discontinuity does not. Our energy distributions show that several O9.5—B0.5 Ia supergiants have Balmer discontinuities in emission on the Palomar system of absolute calibration. They appear to be continuous across the Balmer discontinuity on the calibration of Hayes. (auth)

4238 NEUTRAL HELIUM LINE STRENGTHS. VIII. LINE PROFILES IN THE WEAK-HELIUM-LINE STAR 3 SCORPII. Norris, J. (Yale University Observatory); Strittmatter, P.A. Astrophys. J. 196: No. 2, 515-520 (1 Mar 1975).

It is shown that the profiles of the diffuse helium lines in the weak-helium-line star 3 Sco are anomalously broad and shallow in relation to results obtained for various metal lines. An explanation is proposed in terms of partial gravitational settling which gives rise to a nonuniform distribution of helium either in patches on the surface or in depth. Various constraints and consequences of these alternatives are considered, but neither could be ruled out on the basis of present observational data. (auth)

4239 NUCLEAR AND NONNUCLEAR ABUNDANCE PATTERNS IN THE MANGANESE STARS. Cowley, C.R.; Aikman, G.C.L. (Dominion Astrophysical Observatory). Astrophys. J. 196: No. 2, 521-524 (1 Mar 1975).

The manganese stars show abundance anomalies that are in conflict with the predictions of nuclear astrophysics. We stress the deviations from the odd-even effect that occur for phosphorus, gallium, and yttrium. The abundance anomalies (e.g., the Mn/Fe ratio) in the iron peak are less serious; within the uncertainties of the current determinations, they may be explained in terms of the same processes that predict the solar-system abundances. (auth)

4240 THERMAL PULSES: p-CAPTURE, α-CAPTURE, s-PROCESS NUCLEOSYNTHESIS; AND CONVECTIVE MIXING IN A STAR OF INTERMEDIATE MASS. Iben, I. Jr. (University of Illinois, Champaign-Urbana). Astrophys. J. 196: No. 2, 525-547 (1 Mar 1975).

After extrapolating from the characteristics of a model star of mass 7 $M_\odot$ during the course of 10 thermal relaxation oscillations, the following inferences are drawn: (1) The reaction $^{22}Ne(\alpha,n)^{25}Mg$ serves as a major source of neutrons for s-process nucleosynthesis. (2) This nucleosynthesis takes place at the high temperature base of a convective shell of mass 0.002 $M_\odot$ at and near the peak of a thermal pulse which recurs at intervals of roughly 2500 yr. (3) At maximum size, the convective shell extends from the position of highest helium-burning rate to just below the hydrogen-helium discontinuity, and no further. (4) The ^{22}Ne that is the immediate precursor of neutrons owes its formation to the ^{14}N that has been left behind by the hydrogen-burning shell during the interpulse phase; after two α-captures and a β decay, ^{14}N is converted completely into ^{22}Ne within the convective shell. (5) Following the disappearance of the convective shell, the base of the convective envelope extends into the outer portion of the region previously contained in the convective shell; fresh products of p-capture, α-capture, and s-process nucleosynthesis are then convected to the surface; in particular, surface abundances of ^4He, ^{22}Ne, ^{25}Mg, and the s-process progeny of ^{25}Mg and ^{56}Fe are enhanced, and the abundance of ^{12}C may also be enhanced. Adopting solar abundances of ^{56}Fe and CNO elements, one may infer that roughly 42 neutrons will be released in the convective shell for every fresh ^{56}Fe nucleus. Neutron captures on ^{22}Ne, on ^{25}Mg, and on the progeny of these nuclei reduce the number of neutrons available for capture on ^{56}Fe and its progeny to about four or five, exactly the number required to establish a steady-sate distribution of s-process elements that closely resembles the distribution in the solar system. As a consequence of burning within the convective envelope during interpulse phases, the surface abundance of ^{14}N continues to increase at the expense of ^{12}C, and the number ratio $^{12}C/^{13}C$ approaches 3.4. Whether or not injections of fresh ^{12}C that occur immediately following each pulse can counteract the destruction of ^{12}C during the interpulse phases depends on the treatment of convection in surface layers. One may anticipate that the ratio $^{13}C/^{12}C$ will be correlated with the ratio $^{16}O/^{12}C$ at the surface of stars in which many pulses have occurred. During the quiescent phase that follows each pulse, the hydrogen-burning shell converts CNO nuclei almost entirely into ^{14}N at an abundance that slowly increases after each pulse. Thus, the abundance of ^{22}Ne, the final source of neutrons, increases after each pulse. One may infer that the mass-weighted mean of s-process elements heavier than ^{56}Fe that appears at the stellar surface will be larger in stars with a lower initial iron abundance. (auth)

4241 NEON-22 AS A NEUTRON SOURCE, LIGHT ELEMENTS AS MODULATORS, AND s-PROCESS NUCLEOSYNTHESIS IN A THERMALLY PULSING STAR. Iben, I. Jr. (University of Illinois, Champaign-Urbana). Astrophys. J. 196: No. 2, 549-558 (1 Mar 1975).

If the reaction $^{22}Ne(\alpha,n)^{25}Mg$ is the major source of neutrons in the convective shell of a thermally pulsing star, the fraction of emitted neutrons that can be captured by ^{56}Fe and its neutron-capture progeny is controlled by ^{22}Ne, ^{25}Mg, and the neutron-capture progeny of ^{22}Ne and ^{25}Mg. Adopting currently quoted neutron-capture cross sections and choosing the initial ratio of ^{22}Ne to ^{56}Fe to be within a factor of 2 of the solar system value, it is shown that from three to six neutrons are captured by ^{56}Fe and its progeny for every fresh ^{56}Fe engulfed by the convective shell during a thermal pulse. The resultant distribution of heavy s-process elements resembles the solar system distribution. (auth)

4242 ENVELOPE EJECTION TO FORM PLANETARY NEBULAE. Stry, P.E. (Joint Institute for Laboratory Astrophysics, University of Colorado). Astrophys. J. 196: No. 2, 559-563 (1 Mar 1975).

Previous calculations at $L/L_{crit} \simeq 0.5$ are extended to higher luminosities to determine whether partial, small-scale ejections of mass continue to be the general result. The 0.2 $M_\odot$ envelope of a 1.2 $M_\odot$ star was perturbed by raising the interior boundary condition luminosity 10 percent to $L \simeq L_{crit}$. After a brief period of oscillation the entire envelope was ejected. The numerical methods include time dependent convection (not necessarily efficient) and a simplified version of a spherically extended atmosphere. (auth)

4243 THERMAL INSTABILITY IN SUPERNOVA SHELLS. McCray, R.; Stein, R.F. (Joint Institute for Laboratory Astrophysics, University of Colorado); Kafatos, M. Astrophys. J. 196: No. 2, 565-570 (1 Mar 1975).

Thermal instability in the radiative cooling region behind a shock will cause upstream density fluctuations to collapse into thin sheets aligned parallel to the shock front. A linearized calculation demonstrates the development of this instability. Thermal conduction suppresses the development of small-scale perturbations. Estimates of the scale sizes for fully developed condensations agree roughly with the scale sizes of fine structure observed in supernova shells such as the Cygnus Loop. (auth)

4244 THE NUCLEATION AND EXPULSION OF CARBON PARTICLES FORMED IN STELLAR ATMOSPHERES. Tabak, R.G.; Hirth, J.P.; Meyrick, G.; Roark, T.P. (The Ohio State University). Astrophys. J. 196: No. 2, 457-463 (1 Mar 1975).

The conditions for significant nucleation of carbon particles to occur in several late-type stellar atmospheres are considered. The theoretical treatment includes the contributions from the translational, rotational, and vibrational degrees of freedom of the nuclei which have been omitted in previous considerations. It is shown that the range of possible surface free energies of the particles, for which nucleation can be achieved in these atmospheres, is small. The effects of electrostatic drag on escaping particles are discussed. Under the conditions

considered here, these effects are shown to be of secondary importance to those of viscous drag. (auth)

4245 A PHOTOMETRIC STUDY OF NGC 2419. Racine, R.; Harris, W.E. (David Dunlap Observatory, Richmond Hill, Ontario). Astrophys. J. 196: No. 2, 413-432 (1 Mar 1975).

Photometry to $V=22.2$ and $B=23.7$ is reported for the outer-halo globular cluster NGC 2419. The color-magnitude diagram of the cluster is similar to that of the classic metal-poor cluster M92, and indicates a very low metallicity $Z\simeq 1.5\times10^{-4}$. The reddening $E\,(B-V)$ is 0.03 ± 0.01 mag, and the apparent distance modulus is $(m-M)_v=19.87\pm0.09$, leading to a galactocentric distance of $R_g=100\pm5$ kpc. The RR Lyrae nature of the numerous short-period variables discovered by Baade is confirmed; of the five known brighter variables, one appears to be a Population II Cepheid, while the others fall near the tip of the red giant branch. Attention is drawn to a significant gap in the giant branch. The cluster's age is estimated as $T=11.0\pm0.5\times10^9$ yr from its HB morphology, or $T=11.9\pm0.3\times10^9$ yr from a discussion of its galactic orbit. The galactic orbit of NGC 2419 is determined. The cluster is gravitationally bound to the Galaxy, traveling on an orbit of eccentricity 0.62 with a period of 3.4×10^9 yr, and is presently near its apogalacticon. It is argued that the cluster was born close to its perigalacticon distance of 24 kpc. A possible gravitational encounter between NGC 2419 and the Magellanic Clouds is mentioned briefly. Finally it is shown that NGC 2419, like clusters with the largest h are among the metal poorest. (auth)

4246 COLOR-MAGNITUDE DIAGRAMS FOR FOUR RICH CLUSTERS OF THE LARGE MAGELLANIC CLOUD. Flower, P.J.; Hodge, P.W. (Astronomy Department, University of Washington, Seattle). Astrophys. J. 196: No. 2, 369-380 (1 Mar 1975).

Color-magnitude diagrams are presented for four very rich clusters of the Large Magellanic Cloud. Comparisons with theoretical color-magnitude diagrams show good agreement in the location and distribution of stars in the giant regions. All four have nearly identical ages of approximately 5×10^7 years. Each cluster has at least one anomalously luminous giant of intermediate color and $M_v\simeq-5.7$, over a magnitude brighter than both the observed and predicted giant branch. (auth)

4247 LINE BLANKETING AND OPACITY PROBABILITY DISTRIBUTION FUNCTION. van Paradijs, J.; Vardya, M. S. (Astronomical Institute, Amsterdam, The Netherlands). Astrophys. Space Sci.; 33: No. 1, L9-L12(Mar 1975).

Advantages and limitations of using opacity probability distribution function (OPDF) in computations of model atmospheres for cool stars have been examined. It is concluded that a direct approach, in which a large number of frequency points are taken, may be more appropriate relative to OPDF. (auth)

4248 A PHYSICALLY REALISTIC SPHERE OF PERFECT FLUID TO SERVE AS A MODEL OF NEUTRON STARS. Kuchowicz, B. (Warsaw Univ. (Poland)). Astrophys. Space Sci.; 33: No. 1, L13-L14(Mar 1975).

A new exact solution of Einstein's equation is derived, which constitutes a generalization of the well-known internal Schwarzschild solution, and may be applied to relativistic spheres with a finite density increase toward the centre. (auth)

4249 SOLUTION OF THE TRANSFER EQUATION IN A SCATTERING ATMOSPHERE WITH SPHERICAL SYMMETRY. Missana, M. (Oxford Univ. (UK). Dept. of Astrophysics). Astrophys. Space Sci.; 33: No. 1, 245-251(Mar 1975).

An exact formal solution of the n-approximation radiative transfer equations for the Compton scattering in a spherically symmetric atmosphere is obtained. In view of further applications, the simple case of a density $Q(r) = Q_0/r$ is fully developed and the 20 approximation equations have been studied with the computer. (auth)

4250 VIBRATIONAL STABILITY OF STARS IN THERMAL IMBALANCE: A SOLUTION IN TERMS OF ASYMPTOTIC EXPANSIONS. II. The General 'Non-Isentropic' Oscillations. Demaret, J. (Liege Univ. (Belgium). Inst. d'Astrophysique). Astrophys. Space Sci.; 33: No. 1, 189-213(Mar 1975).

The solution of the partial differential equation describing the "non-isentropic" oscillations of a star in thermal imbalance has been obtained in terms of asymptotic expansions up to the first order in the parameter Π/t_s where Π is the adiabatic pulsation period for the fundamental mode and t_s, a secular time scale of the order of the Kelvin–Helmholtz time. Use has been made of the zeroth order "isentropic" solution. The solution obtained allows one to derive unambiguously a general integral expression for the coefficient of vibrational stability for arbitrary stellar models in thermal imbalance. The physical interpretation of this stability coefficient is discussed and its generality and its simplicity are stressed. Application to some simple analytic stellar models in homologous and nonhomologous contraction enables one to recover, in a more straightforward manner, results obtained by Cox et al. (1973), Aizenman and Cox (1974), and Davey (1974). Finally, it is emphasized that the inclusion of the effects of thermal inbalance in the stability calculations of realistic evolutionary sequences of stellar models, not considered up to now by the other authors, is quite easy and straightforward with the simple formula derived here. (auth)

4251 THE INTERACTION OF AN OBLIQUELY INCIDENT S-POLARIZED PLANE ELECTROMAGNETIC WAVE AT A WARM MOVING MAGNETIZED PLASMA HALF-SPACE. Mukherjee, P. K.; Talwar, S. P. (Delhi Univ. (India). Dept. of Physics and Astrophysics). Astrophys. Space Sci.; 33: No. 1, 147-163 (Mar 1975).

The interaction of an s-polarized plane electromagnetic wave incident from a dielectric (or vacuum) region on a warm moving magnetized plasma half-space is considered. The external magnetic field is assumed to be normal to the direction of the wave normal and the velocity of the moving medium. Using the first three moment equations, together with Maxwell's electromagnetic equations, the constitutive relations are constructed in the rest frame of the moving medium. The constitutive relations are then transformed to the laboratory frame by invoking Minkowski's equations for the moving plasma medium, and the dispersion relation for the propagating ordinary mode in the moving medium is derived. Expressions are obtained for the phase and group velocities and the index of refraction for the ordinary mode, as also for power reflection and transmission coefficients. It is found that in contrast to the case of a cold magnetized plasma, the ordinary electromagnetic mode excited in the ward magnetoplasma medium gets modified due to the presence of an external magnetic field. In addition, the various reflection and transmission characteristics for a warm magnetoplasma depend on the velocity of the moving plasma as well as on the strength of the applied magnetic field, as against the case for a cold moving magnetized plasma. Numerical results on the reflection coefficient are presented for several values of the parameters characterizing the electron–plasma temperature, the velocity of the moving medium and the strength of the applied magnetic field. (auth)

4252 MAGNETICALLY DISTORTED POLYTROPES. III. Radial, Non-Radial, Toroidal and Transverse Shear Modes of Oscillation. Sood, N. K. (Dept. of Physics, Guru Nanak University, Amritsar, India); Trehan, S. K. (Punjab Univ., Chandigarh (India)). Astrophys. Space Sci.; 33: No. 1, 165-172(Mar 1975).

The oscillations of a gaseous polytrope with a magnetic field having both a toroidal and a poloidal component are examined using the second-order tensor virial equations on the assumption that the magnetic energy is small compared with the gravitational energy. The frequencies of oscillation of the transverse shear, the toroidal and the coupled pulsation modes are tabulated for polytropic indices n = 1, 1.5, 2, 3, and 3.5. It is found that the magnetic field decreases the frequency of oscillation of (i) the transverse shear mode and (ii) the mode which starts as a radial pulsation in the absence of a magnetic field while it increases the frequency of oscillation of (i) the toroidal mode and (ii) the Kelvin mode. In all cases the shift in frequency decreases with increasing n. (auth)

4253 THE STABILITY OF DIFFERENTIAL ROTATION WITH NONASYMMETRIC PERTURBATIONS. II. The Necessary Conditions. Sung, C.-H. (Chicago Univ., Ill. (USA)). Astrophys. Space Sci.; 33: No. 1, 127-140(Mar 1975).

A plane-wave analysis on a simplified scheme based on the Boussinesq approximation and shallow convection is used to establish the necessary conditions for stability of a differentially rotating, compressible flow between two coaxial cylinders subject to nonaxisymmetric perturbations. To test the adequateness of this simplification, the sufficient conditions for stability are again established which agree with those obtained by a normal-mode analysis on an exact scheme in an earlier paper by the author. This model is applicable to stellar models with rotation $\Omega = \Omega(\omega)$, where ω is the radial distance from the axis of rotation (the z-axis). A necessary condition for stability, in the nondissipative case, is found to be that $(1/Q)\,G_\omega S_\omega + (k_z^2/M)\,\Phi - (1/4)\,(m^2/M)\,(D\Omega)^2 \geq 0$ everywhere. Here, m and k_z are the wave numbers in the ϕ^- and z-direction, $M \equiv k_z^2 + m^2/\omega^2$, $D \equiv d/d\omega$, $G_\omega \equiv -Q^{-1}$ Dp, Q the density, p the pressure, S_ω and Φ the Schwarzschild and the Rayleigh discriminants defined as $S_\omega \equiv (\gamma p/Q)^{-2}\,Dp - DQ$ and $\Phi \equiv \omega^{-3}\,d(\omega^4\Omega^2)/d\omega$ respectively, γ the ratio of specific heats. This condition is also a sufficient one. Some conjectures regarding the stabilizing influence of uniform rotation and the destabilizing influence of differential rotation are also verified. The most striking instability mechanism introduced by shear forces and by radiative dissipation is the excitation of the stable motion of small oscillations into that of oscillations with growing amplitude, i.e., overstability. In the case of radiative dissipation and axisymmetric perturbations, the Goldreich–Schubert criterion

is only necessary but not sufficient for stability. Instability sets in as soon as the Schwarzschild criterion is violated. When the perturbations are nonaxisymmetric, instability always sets in as overstability as long as rotation is differential. This may explain the convective turbulence in the upper atmosphere where the radiation is active. (auth)

4254 A NOTE ON THE VALIDITY OF THE USE OF EULER'S EQUATION FOR THE MOTION OF THE MATTER IN THE ENVELOPES OF Be STARS. Morgan, T. H. (National Aeronautics and Space Administration, Houston, Tex. (USA). Manned Spacecraft Center). Astrophys. Space Sci.; 33: No. 1, 99-101(Mar 1975).

Three assumptions which underlie the theoretical treatment of the structure and kinematics of the circumstellar material surrounding Be stars are examined. It is shown that a single-fluid nonviscous hydrodynamical description is a reasonable one for describing the motion of a fluid under typical envelope conditions. (auth)

4255 THE OSCILLATIONS AND THE STABILITY OF ROTATING MASSES WITH MAGNETIC FIELDS. IV. Existence of the Point of Bifurcation. Trehan, S. K.; Singh, M. (Simon Fraser Univ., Burnaby, British Columbia (Canada)). Astrophys. Space Sci.; 33: No. 1, 43-48(Mar 1975).

The existence of the point of bifurcation of rotating gaseous masses with toroidal magnetic fields is established from the first variations of the integral properties provided by the second-order virial relations. It is shown that the point of bifurcation, where the Jacobi ellipsoids branch off from the Maclaurin spheroids, is unaffected by the presence of toroidal magnetic fields. (auth)

4256 THREE-COLOR PHOTOMETRY OF THE ECLIPSING BINARY EI CEPHEI. Padalia, T. D.; Srivastava, R. K. (Uttar Pradesh State Observatory, Naine Tal, India). Astrophys. Space Sci.; 32: No. 2, 285-290(Feb 1975).

The photoelectric elements of the system EI Cephei have been determined in U, B, V colors. The absolute dimensions have been determined and some evolutionary aspects have been discussed. A modified period of 8.439334d has been obtained. The system is a detached one. (auth)

4257 THREE-COLOUR PHOTOMETRY OF TW CAS. Kandpal, C. D. (Uttar Pradesh State Observatory, Naini Tal, India). Astrophys. Space Sci.; 32: No. 2, 291-295(Feb 1975).

Photoelectric elements of the system TW Cas have been determined in U, B, and V filters. A refined period of 1.428 324 77d has been given though no change in period is noticed. Spectroscopic elements given by Struve have been used to get the absolute elements. The system is found to be a detached one. (auth)

4258 ON THE PERIOD VARIATIONS OF RT PERSEI. Mancuso, S.; Milano, L. (Osservatorio Astronomico di Capodimonte, Naples (Italy)). Astrophys. Space Sci.; 32: No. 2, 385-401(Feb 1975).

The observed minima of RT Persei up to 1971 are collected and treated by the method of least squares to establish periodic terms with a fundamental period of 40.0y and, furthermore, a quadratic term. It is shown that the periodic terms might be explained by the presence of a third body, but this hypothesis seems unlikely, and could be definitively ruled out by new spectroscopic observations. A dynamical instability of the system may constitute a more likely explanation of the observed period changes. (auth)

4259 ABNORMAL NEUTRON STARS. Kaellman, C. G. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Phys. Lett., B; 55: No. 2, 178-182(3 Feb 1975).

Quasi-classical field theory is used to predict abnormal behavior of neutron matter in a model with neutrons, scalar mesons and vector mesons. Two stable families of neutron stars are predicted, a conventional one and an unconventional one with surface density in excess of 10^{15}g cm^{-3}, roughly. (auth)

4260 OPTICALLY THICK ACCRETION ONTO BLACK HOLES. Tamazawa, S.; Toyama, K.; Kaneko, N.; Ono, Y. (Hokkaido Univ., Sapporo (Japan). Dept. of Physics). Astrophys. Space Sci.; 32: No. 2, 403-421(Feb 1975).

Spherically symmetric, steady-state, optically thick accretion onto a nonrotating black hole with the mass of $M = 1M_{\odot}$ is studied. The gas accreting onto the black hole is assumed to be a fully ionized hydrogen plasma with $n_0 = 10^8$ cm^{-3} and $T_0 = 10^4$ K far from the black hole, and a new approproximate expression for the Eddington factor is introduced. The luminosity is estimated to be $L = 1.875 \times 10^{33}$ erg s^{-1}, which primarily arises from the optical surface ($\tau \sim 1$) of $T \sim 10^4$K. The accretion flow is characterized by $\tau \sim 1$ and $(v/c)\tau \sim 10$. In the optically thin region, the flow remains isothermal, and the increase of temperature occurs at $\tau \sim 1$. The radiative equilibrium is strictly realized at $(v/c)\tau \sim 10$. (auth)

4261 LIST AND CLASSIFICATION OF NEW M, C, AND EMISSION STARS. Barbier, M. (Observatoire de Marseille, 13 (France)). Astrophys. Space Sci.; 32: No. 2, 423-430(Feb 1975). (In French).

A new list of 156 M, C, or emission line stars discovered on objective-prism plates taken at Haute Provence Observatory are presented. The good spectra are classified by means of criteria used in previous publications, principally from the ratio of TiO bands. (auth)

4262 SOLAR NEUTRINOS AND EXPERIMENTS TO SEARCH FOR THE HYPOTHETICAL LEVEL IN ^{6}Be. Fetisov, V. N. (AN SSSR, Moscow. Fizicheskij Inst.); Kopysov, Yu. S. (AN SSSR, Moscow. Inst. Yadernykh Issledovanij). Nucl. Phys., A; 239: No. 3, 511-529(3 Mar 1975).

The problem of solar neutrinos is discussed, as well as the restrictions imposed on the parameters of the hypothetical level in ^{6}Be and experiments to search for new levels in nuclei with A = 6. (auth)

4263 R-PROCESS NUCLEOSYNTHESIS AND NUCLEI FAR FROM THE REGION OF β-STABILITY. Kodama, T. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro); Takahashi, K. (Aarhus Univ. (Denmark)). Nucl. Phys., A; 239: No. 3, 489-510 (3 Mar 1975).

The gross theory of β-decay is applied to make improved estimates of the absolute magnitude of β-decay half-lives and related variables in the r-process calculation. The time necessary for synthesis seems to be considerably longer than assumed in some of the recent studies of the dynamic r-process. This means the necessity of suitable rescaling of the expansion rates in the dynamics. Although the application of the improvements to the dynamics is most interesting, the present paper has limited itself to the classical quasi-static model of Seeger, Fowler and Clayton in performing the abundance calculation. The calculation method of the final abundance curve can allow several nuclear processes to interrupt β-decay cascades before the β-stability region is reached. The sudden freezing of neutron flux and temperature is assumed to precede these processes. In particular, the effect of β-delayed neutron emission after freezing is extensively studied. The β-delayed fission is also discussed. The calculated β-strength functions are compared with the recent experimental data obtained at the ISOLDE and OSIRIS facilities. (auth)

4264 DESTRUCTION AND PRODUCTION OF MOLECULES IN CIRCUMSTELLAR REGIONS OF T TAURI STARS. Gahm, G. F. (Stockholm Observatory, Saltsjoebaden, Sweden). Astrophys. Space Sci.; 32: No. 2, 297-304(Feb 1975).

It is shown that the lifetimes of molecules against photodissociation in circumstellar envelopes of T Tauri stars are very short. The production rates of CO through gas-phase reactions are not sufficient to keep the equilibrium column densities at an observable level. The absence of molecular features reported for this class of stars is qualitatively understood. (auth)

4265 THE POLARIZATION OF OPTICAL RADIATION FROM THE MAGNETIC WHITE DWARFS. Sazonov, V. N.; Chernomordik, V. V. (AN SSSR, Moscow. Fizicheskij Inst.). Astrophys. Space Sci.; 32: No. 2, 355-369(Feb 1975).

It is pointed out that, because of the large Faraday rotation an outlet of linear polarization from the photosphere of a white dwarf is hampered. In accordance with this fact it is proposed to distinguish two types of magnetic white dwarfs. The first type (its representative is Grw 70°8247) has a linear polarization which is comparable in magnitude with the circular one. Polarization of radiation from the white dwarfs of the first type cannot arise in the photosphere. It arises in the corona of the star as a result of cyclotron emission of hot electrons ($T \sim 10^8$K) or as a result of scattering of slightly polarized emission from the photosphere in the corona. For the first type dwarfs such magnetic fields are required that $\omega B = \omega_{opt}$, i.e. $B = (1-3) \times 10^8$ G. The white dwarfs of the second type (its representative is G 99-37) have their linear polarization much smaller than the circular one. Polarization of these white dwarfs can arise as a result of the transfer of radiation in the nonisothermal photosphere. Magnetic fields required for the second type can be much smaller: $B \cos\gamma = (1 = 10) \times 10^6$ G. It is shown that the photospheric model allows to obtain the quantitative accordance of the theory with all the observational data for G99-37 and is not in accordance with the data for Grw 70°8247, at the same time the model with cyclotron emission from the corona explains the magnitude of both linear and circular polarization and their wavelength dependence for Grw 70°8247. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 4223, 4360, and 4718.

4266 FINE STRUCTURE OF 25 EXTRAGALACTIC RADIO SOURCES. Wittels, J.J.; Knight, C.A.; Shapiro, I.I. (Massachusetts Institute of Technology); Hinteregger, H.F.; Rogers, A.E.E.; Whitney, A.R.; Clark, T.A.; Hutton, L.K.; Marandino, G.E.; Niell, A.E.; Rönnäng, B.O.; Rydbeck, O.E.H.; Klemperer, W.K.; Warnock, W.W. Astrophys. J. 196: No. 1, 13-39 (15 Feb 1975).

Between 1972 April and 1973 May, 25 extragalactic radio sources were observed interferometrically at 7.8 GHz($\lambda \simeq 3.8$ cm) with five pairings of antennas. These sources exhibit a broad variety of fine structures from very simple to complex. Although the structure and the total power of some of these sources have remained unchanged within the sensitivity of our measurements during the year of observations, both the total flux and the correlated flux of others have undergone large changes in a few weeks. (auth)

4267 OPTICAL RADIATION FROM THE CRAB PULSAR. Sturrock, P.A.; Petrosian, V.; Turk, J.S. (Institute for Plasma Research, Stanford University). Astrophys. J. 196: No. 1, 73-82 (15 Feb 1975).

Possible mechanisms for producing the optical radiation from the Crab pulsar are proposed and discussed. There are several difficulties in interpreting the radiation as being produced by an incoherent process, whether it be synchrotron radiation, inverse-Compton radiation, or curvature radiation. It is proposed, therefore, that radiation in the optical part of the spectrum is coherent. In the polar cap model, a small bunch of electrons and positrons forms near each primary electron as a result of the pair-production cascade process. Turbulent electric field components associated with large-scale bunching may lead to separation of the electrons and positrons in space and in energy, with the result that coherent radiation may be produced by the electrons, the positrons, or both. Calculations, which involve a number of simplifying assumptions, indicate that the optical radiation from the Crab pulsar can be understood in this way if the mass of the star is approximately $0.3\,M_{\odot}$. Various consequences of this model, which may be subjected to observational test, are discussed. (auth)

4268 OBSERVATIONS OF PULSAR RADIO EMISSION. II. POLARIZATION OF INDIVIDUAL PULSES. Manchester, R.N.; Taylor, J.H.; Huguenin, G.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst). Astrophys. J. 196: No. 1, 83-102 (15 Feb 1975).

Observations of the complete polarization characteristics of individual pulses at frequencies between 110 and 450 MHz are presented for a total of 12 pulsars, together with linear polarization characteristics at 1400 MHz for four pulsars. Subpulses are often highly polarized, with linear polarization generally dominating over circular; the variation of position angle within a subpulse is usually less than 30°. Weakly polarized subpulses are also common, with the fractional polarization generally different at different longitudes. Significant circular polarization is observed in several pulsars, in some cases apparently retaining the same sense through a subpulse, and in other cases reversing in sense within a subpulse. In many pulsars, particularly at low frequencies, the position angle of successive subpulses is quite stable for most of the profile. For certain components, however, subpulses are sometimes observed with position angle orthogonal to the most common angle. These orthogonally polarized subpulses appear to be a general feature of pulsar radio emission, and are observed in at least one component of nearly all the pulsars studied. Apart from their orthogonal position angle, they appear to have very similar properties to normal subpulses. An interpretation based on self-absorption in the emission region is discussed. The pulsars studied include several with strong, drifting subpulses. Orthogonal emission is also observed in these sources, with the leading edge of the subpulse at one angle and the trailing edge at the orthogonal angle; the position angle transition drifts across the profile with the subpulses. The orthogonal emission contributes to depolarization of integrated profiles. For most sources, the position angle of subpulses becomes more random at higher frequencies, this being the primary reason for the smaller fractional polarization observed in integrated profiles at higher frequencies. (auth)

4269 THE HELIUM LINES IN THE SPECTRUM OF SCORPIUS X−1. Chesley, S.E. (Department of Physics and Astronomy, Dartmouth College). Astrophys. J. 196: No. 1, 103-106 (15 Feb 1975).

Equivalent widths and relative line intensities for He II λ4684, He I λ5876, and He I λ5015.7 are determined as a function of B magnitude for Sco X−1. These are used to investigate the temperature variations of the line-forming region. (auth)

4270 POLARIZATION OF RADIO SOURCES. VI. AN OSCILLATORY BEHAVIOR OF THE INTENSITY IN A GENERAL SOLUTION OF THE RADIATION TRANSFER PROBLEM IN A PLASMA. Pacholczyk, A.G.; Swihart, T.L. (Steward Observatory, University of Arizona). Astrophys. J. 196: No. 1, 125-127 (15 Feb 1975).

The solution for a general form of the transfer equation is given. The total intensity is found to oscillate under general conditions, although the oscillations vanish under most special cases discussed previously in the literature. The oscillations are a manifestation of the Faraday effects and their interaction with polarized absorption. (auth)

4271 PROPERTIES OF THE HULSE-TAYLOR BINARY PULSAR SYSTEM. Esposito, L.W.; Harrison, E.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst). Astrophys. J. Lett. 196: No. 1, L1-L2 (15 Feb 1975).

Various elementary calculations are summarized concerning the close-binary-system pulsar PSR 1913+16, discovered by Hulse and Taylor. The results are approximate and indicate only the relative importance of various relativistic and nonrelativistic effects. (auth)

4272 PERIASTRON SHIFTS IN THE BINARY SYSTEM PSR 1913+16: THEORETICAL INTERPRETATION. Will, C.M. (Institute for Theoretical Physics, Department of Physics, Stanford University). Astrophys. J. Lett. 196: No. 1, L3-L5 (15 Feb 1975).

Measurements of the shift in the periastron of a recently discovered close binary system containing a pulsar may be interpreted in several ways: as a test of relativistic gravity, as a means of measuring the total mass of the system, or as a means of setting limits on the size and structure of the pulsar's companion. We present formulae for the relativistic periastron shift and for the shift produced by the bodies' quadrupole moments, and discuss each interpretation in detail. (auth)

4273 SOFT X−RAY SURVEY OF THE LARGE MAGELLANIC CLOUD. Rappaport, S.; Levine, A.; Doxsey, R.; Bradt, H.V. (Physics Department and Center for Space Research, Massachusetts Institute of Technology). Astrophys. J. Lett. 196: No. 1, L15-L18 (15 Feb 1975).

A soft X-ray survey (0.15−1.5 keV) of the Large Magellanic Cloud, during a sounding rocket flight, reveals possible emission from the centrally located barlike structure. No evidence was seen for absorption of the soft X-ray "background" in the direction of the LMC. Both of these observations support the hypothesis of a local production of the soft X-ray background. (auth)

4274 *COPERNICUS*: SOFT X−RAY EMISSION FROM CERTAIN FEATURES OF THE CYGNUS LOOP. Charles, P.A.; Culhane, J.L.; Zarnecki, J.C. (Mullard Space Science Laboratory, Department of Physics and Astronomy, University College London, Holmbury St. Mary, Dorking, Surrey). Astrophys. J. Lett. 196: No. 1, L19-L22 (15 Feb 1975).

The MSSL 0.5−1.5 keV X-ray telescope on Copernicus has examined several features of previous X-ray maps of the Cygnus Loop. We derive fluxes and spectra for the north and northeastern filamentary regions, together with an upper limit for the X-ray flux from the radio source labeled CL4 by Keen *et al.* Correlation between the X-ray and radio structure is established. (auth)

4275 AN INCREASE IN THE X−RAY FLUX FROM CENTAURUS A. Davison, P.J.N.; Culhane, J.L.; Mitchell, R.J. (Mullard Space Science Laboratory, Department of Physics and Astronomy, University College London); Fabian, A.C. Astrophys. J. Lett. 196: No. 1, L23-L25 (15 Feb 1975).

The X-ray spectrum of Cen-A has been studied in the energy range 0.5–7.5 keV. The value of absorbing gas column density and power law index are consistent with those determined by *Uhuru*, but the 2.5–7.5 keV luminosity is found to have increased by a factor of 4. (auth)

4276 SYNCHROTRON EMISSION FROM AN OBLIQUE ROTATOR AND ITS APPLICATION TO PULSARS. Miller, B.; Eastlund, B.J. (Division of Controlled Thermonuclear Research, U.S. Atomic Energy Commission, Washington, D.C. 20545). Phys. Rev. Lett. 34: No. 14, 901-905 (7 Apr 1975).

A method is presented which permits rapid interpretation of the synchrotron patterns emitted by a charged particle moving in the uniform magnetic field of an oblique rotator. The analysis predicts a variety of intensity and polarization patterns that are compared with data from a number of pulsars. It also predicts the observed frequency dependence of the peak-to-peak separation of two double-peaked pulsars. (auth)

4277 BRIGHTNESS DISTRIBUTION DATA ON 2918 RADIO SOURCES AT 365 MHz. Cotton, W.D.; Owen, F.N.; Ghigo, F.D. (University of Texas Radio Astronomy Observatory and Department of Astronomy, The University of Texas at Austin, Austin, Texas). Astron. J. 80: No. 5, 353-378 (May 1975).

This paper is the second in a series describing the results of a program attempting to fit models of the brightness distribution to radio sources observed at 365 MHz with the Bandwidth Synthesis Interferometer (BSI) operated by the University of Texas Radio Astronomy Observatory. Results for a further 2918 radio sources are given. An unresolved model and three symmetric extended models with angular sizes in the range 10–70 arcsec were attempted for each radio source. In addition, for 348 sources for which other observations of brightness distribution are published, the reference to the observations and a brief description are included. (auth)

4278 SOFT X−RAY OBSERVATIONS OF CENTAURUS X-3 FROM *COPERNICUS*. Margon, B. (Space Sciences Laboratory, University of California, Berkeley); Mason, K.O.; Hawkins, F.J.; Sanford, P.W. Astrophys. J. Lett. 196: No. 2, L51-L53 (1 Mar 1975).

We have detected soft X-ray emission from Centaurus X-3 in the 0.6−1.9 keV band, using the focusing telescope aboard OAO *Copernicus*.

The flux is compatible with an extrapolation of the harder X-ray spectrum, attenuated by $3-4\times10^{22}$ atoms cm^{-2} of interstellar and/or circumstellar matter. The data are consistent with the distance estimate of 5–10 kpc derived from the spectroscopic modulus of the optical component, and obviate the need to postulate the primary to be an anomalously subluminous hot star. There is currently no compelling evidence that such models must be invoked to explain any of the observed compact X-ray sources. (auth)

4279 OBSERVATIONS OF X—RAY SOURCES IN THE LARGE MAGELLANIC CLOUD BY THE OSO-7 SATELLITE. Markert, T.H.; Clark, G.W. (Department of Physics and Center for Space Research, Massachusetts Institute of Technology). Astrophys. J. Lett. 196: No. 2, L55-L58 (1 Mar 1975).

Observations of the Large Magellanic Cloud with the 1–40 keV X-ray detectors on the OSO-7 satellite are reported. Results include the discovery of a previously unreported source LMC X-5, measurements of the spectral characteristics of four sources, and observations of their variability on time scales of months. (auth)

4280 OBSERVABLE EFFECTS OF A SCALAR GRAVITATIONAL FIELD IN A BINARY PULSAR. Eardley, D.M. (Physics Department, Yale University). Astrophys. J. Lett. 196: No. 2, L59-L62 (1 Mar 1975).

It is remarked that the Dicke-Brans-Jordan theory of gravitation predicts *dipole* gravitational radiation from certain binary systems that contain a neutron star or black hole, causing decay of the orbit. Further, it predicts that the true rate of a pulsar clock should vary with distance from a binary companion (other than a black hole). At least one of these effects would be observable in PSR 1913+16. (auth)

4281 TEST FOR THE EXISTENCE OF GRAVITATIONAL RADIATION. Wagoner, R.V. (Institute of Theoretical Physics, Department of Physics, Stanford University). Astrophys. J. Lett. 196: No. 2, L63-L65 (1 Mar 1975).

Predictions are presented for the gravitational-radiation-induced decrease of the orbit period and eccentricity of the recently discovered radio pulsar in a binary system, in terms of the mass ratio and angle of inclination of the orbit. It is shown how measurements of the rotation of the periastron and the term of order $(v/c)^2$ in the pulsar period variation would allow these two unknowns to be determined. (auth)

4282 TIMING EFFECTS IN PULSED BINARY SYSTEMS. Wheeler, J.C. (Department of Astronomy, University of Texas at Austin). Astrophys. J. Lett. 196: No. 2, L67-L70 (1 Mar 1975).

An analysis of a binary stellar system is made in terms of arrival-time data. This is the form which pertains most directly to systems in which one star pulses with an accurately known period, as is the case with the recently discovered binary pulsar and the pulsed binary X-ray sources. Measurement of differences of order 100 μs in time of arrival across the orbit might in principle serve to determine both masses and the inclination angle in the case of the binary pulsar, independent of the rotation of the periastron. Measurement to $\lesssim 1$ ms serve to determine the mass of the primary in Cen X-3. (auth)

4283 A SEARCH FOR THE ZEEMAN EFFECT IN THE X-RAY STAR CANDIDATES θ^2 ORIONIS AND X PERSEI, THE X-RAY SOURCE CYGNUS X-1, AND THE B2 Ib STAR HD 31327. Borra, E.F. (Hale Observatories, Carnegie Institution of Washington, California Institute of Technology). Astrophys. J. Lett. 196: No. 3, L109-L111 (15 Mar 1975).

Observations of the circular polarization in the wings of the He I line λ6678 in the X-ray star candidates θ^2 Orionis A and X Persei, the X-ray star HDE 226868 (Cygnus X-1), and the B2 Ib star HD 31327 do not show evidence of the longitudinal Zeeman effect. (auth)

4284 THE SPECTRA OF 3C 273 AND PKS 0736+01. Baldwin, J.A. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. Lett. 196: No. 3, L91-L93 (15 Mar 1975).

The spectra of the quasi-stellar objects 3C 273 and PKS 0736+01 are found to be almost identical, having strong Fe II, hydrogen, and helium permitted lines, but no forbidden lines. These spectra are quite distinct from typical low-redshift QSO spectra, and may be difficult to explain with models where photoionizations are the principal ionization mechanism. This may point to a different ionization and heating mechanism for the gas in 3C 273-type QSOs than in normal QSOs. (auth)

4285 UPPER LIMITS OF HARD GAMMA-RAY EMISSION FROM SIX X—RAY SOURCES. Campbell, M.; Alexander, J.; Ball, S.E. Jr.; Greisen, K.; Koch, D.; McBreen, B. (Laboratory of Nuclear Studies, Cornell University). Astrophys. J. 196: No. 2, 593-595 (1 Mar 1975).

The Cornell 100-inch γ-ray telescope has been used to set upper limits for the γ-ray flux above 400 MeV from the X-ray sources Cyg X-1, Cyg X-2, Cyg X-3, Cas A, Cas B, and Per X-1. An upper limit for the diffuse flux of the galactic disk was set which is consistent with OSO-3 and SAS-2 data. A new measurement of the atmospheric γ-ray generation rate is presented. (auth)

4286 ENERGY SPECTRUM VARIABILITY OF CYGNUS X-1 IN HARD X—RAYS. Frontera, F.; Fuligni, F. (Laboratorio Technologie e Studio Radiazioni Extraterrestri, Consiglio Nazionale delle Ricerche, Bologna, Italy). Astrophys. J. 196: No. 2, 597-599 (1 Mar 1975).

Energy spectrum analysis of a balloon observation of Cygnus X-1 is reported. During a period of flaring activity of the source, a much softer spectrum than usual, fitted by a power law with number index 2.7, has been found. The "normal status" of flux is attained in a rather smooth way. During this last period the energy spectrum is well represented by a power law with number index 1.84, in agreement with other observations. (auth)

4287 PULSAR GEOMETRIES. I. BASIC MODEL. Oster, L. (Institut für Astrophysik und Extraterrestrische Forschung, Universität Bonn). Astrophys. J. 196: No. 2, 571-577 (1 Mar 1975).

A "geometrical" model for pulsar emissions is presented according to which they occur *perpendicular* to organized magnetic field structures, but in finite sets of narrow beams that rotate with constant speed in the plane perpendicular to the field; such a "wagon wheel" pattern might arise out of interference among wedgeshaped patterns of coherent synchrotron radiation near the surface of the neutron star, or it may be related to standing plasma waves in a circumstellar magnetic field. No further requirements are necessary with regard to this emission mechanism to interpret the existence and preferred location of interpulses, fast and slow pulse-amplitude modulations, and drifting subpulses in terms of the inclination of magnetic field and rotational axes of the neutron star, and the accidental latitude position of the observer. (auth)

4288 NEUTRAL HYDROGEN ASSOCIATED WITH SUPERNOVA REMNANTS. I. THE CYGNUS LOOP. DeNoyer, L.K. (University of Illinois). Astrophys. J. 196: No. 2, 479-487 (1 Mar 1975).

Observation of H I near the Cygnus Loop show that (1) the remnant is encountering interstellar clouds with densities 5–10 cm^{-3} adjacent to its optical filaments, and (2) the remnant does not contain the cool H I shell as predicted by current evolution theories which equate the present shock velocity with the optical expansion velocity. It is suggested that the remnant is adiabatically expanding into a two-phase medium, and the original energy of the explosion was 10^{51} ergs. (auth)

4289 A CROSS-DISPERSED ECHELETTE SPECTROGRAPH AND A STUDY OF THE SPECTRUM OF THE QSO 1331+170. Carswell, R.F.; Hilliard, R.L.; Strittmatter, P.A.; Taylor, D.J.; Weymann, R.J. (Steward Observatory, University of Arizona). Astrophys. J. 196: No. 2, 351-361 (1 Mar 1975).

A simple modification of the Cassegrain spectrograph of the Steward Observatory 90-inch (2.3 m) telescope is described. The system utilizes a grating operating in the 5–13th orders and a quartz prism to cross-disperse these orders in an echelle format. Complete spectral coverage from 3100 Å to about 9000 Å on a 40-mm image tube is possible with a dispersion of 44 Å mm^{-1} at 4200 Å. With this equipment, an image-tube spectrogram of the absorption-rich quasi-stellar object 1331+170 has been obtained. A large number of previously undetected absorption lines are shown to be present in this object. The two absorption systems, noted by Strittmatter *et al.*, at $z_A = 1.7754$ and $z_B = 1.7851$ are confirmed; but despite the improved coverage only one further probable system, with $z_C = 1.3273$, could be found. Evidence for line locking between the absorption lines of the two well-established redshift systems, and between the absorption and emission line systems, is discussed. The strong Lα absorption feature common to systems A and B is similar to that of Lα in system A ($z = 2.309$) in PHL 957. System B seems to arise in a pure H I cloud and in this respect is also similar to system A in PHL 957. (auth)

4290 FLUX DENSITY MEASUREMENTS OF RADIO SOURCES AT 2.14 MILLIMETER WAVELENGTH. Cogdell, J.R.; Davis, J.H. (Electrical Engineering Research Laboratory, The University of Texas at Austin); Ulrich, B.T.; Wills, B.J. Astrophys. J. 196: No. 2, 363-368 (1 Mar 1975).

Flux densities of galactic and extragalactic sources, and planetary temperatures, have been measured at 2.14 mm wavelength (140 GHz). Results are presented for OJ 287; the galactic sources DR 21, W3, and Orion A; the extragalactic sources PKS 0106±01, 3C 84, 3C 120, BL Lac, 3C 216, 3C 273, 3C 279, and NGC 4151; and the Sun, Venus, Mars, and Jupiter. Also presented is the first measurement of the 2.14-mm temperature of Uranus. The spectra of some of these sources are discussed. The flux density scale was calibrated absolutely. The measurements were made with a new continuum receiver on the 4.88-m radio telescope of The University of Texas. (auth)

4291 ELECTROHYDRODYNAMICS OF THE PULSAR MAGNETOSPHERE. Heintzmann, H. (Koeln Univ. (F. R. Germany). Inst fuer Theoretische Physik); Kundt, W.; Lasota, J. P. (Hamburg Univ. (F. R. Germany). 2. Inst. fuer Theoretische Physik). Phys. Lett., A; 51: No. 2, 105-106(10 Feb 1975).

The dispersion relations for weak waves in a cold, charge-separated plasma (due to a strong rotating magnetic field) show

that radio waves and even low-frequency waves can propagate through a (one-component) pulsar magnetosphere. (auth)

4292 THE ALIGNMENT OF THE CRAB PULSAR MAGNETIC AXIS. Jones, P. B. (Oxford Univ. (UK). Dept. of Nuclear Physics). Astrophys. Space Sci.; 33: No. 1, 215-230(Mar 1975).

The magnetic distortion is estimated for neutron stars in which the matter in the interior consists of superfluid neutrons and superconducting protons. For type II proton superconductivity, the arrangement of magnetic flux in a two-dimensional lattice of quantized fluxoids and the kinetic energy of the supercurrent carriers cause some components of the spatially averaged stress tensor for field and superconductor to be several orders of magnitude greater than the components of the Maxwell stress tensor for a uniform distribution of the same magnetic flux. It is shown that for the Crab pulsar PSR 0531 + 21, which is considered to have the greater part of its mass in the form of superfluid neutrons and superconducting protons, the magnetic distortion is almost certainly more important than the elastic energy of the outer shell in determining the departure of the inertia tensor from its spherically symmetric form. With the assumption that internal and external magnetic fields have the same symmetry axis, the external field dipole moment of the Crab pulsar is predicted to be approximately perpendicular to the spin direction, in agreement with a number of published interpretations of observational data. (auth)

4293 SOME REMARKS ON THE HYPOTHESIS OF RELATIVISTIC BEAMING OF PULSAR EMISSION. Zheleznyakov, V. V.; Shaposhnikov, V. E. (Nauchno-Issledovatel'skij Radiofizicheskij Inst., Gorkij (USSR)). Astrophys. Space Sci.; 33: No. 1, 141-145(Mar 1975).

The hypothesis of the relativistic beaming of pulsar emission is discussed in connection with objections advanced by Manchester et al. (1973). It is shown that the same pulse duration of some pulsars with the non-power-law spectrum over a wide frequency interval may be associated either with large source sizes in longitude, or with location of the emitting source at various distances from the rotation axis of the neutron star (depending on the emission frequency). (auth)

4294 THE RADIO SPECTRA OF THE γ-CYGNI SOURCE AND THE IC 1318b, C NEBULAR COMPLEX. Goudis, C. (Manchester Univ. (UK)). Astrophys. Space Sci.; 33: No. 1, 103-109(Mar 1975).

The radio spectra of both the γ-Cygni radio source and the IC 1318b, c nebular complex are established from all the available data. The nonthermal nature of the γ-Cygni source is established (sp. index -0.93 ± 0.30). The IC 1318b, c shows an optically thin thermal spectrum. The possibility of the γ-Cygni source being a SNR is discussed. (auth)

4295 PULSED HIGH-ENERGY RADIATION FROM OBLIQUE MAGNETIC ROTATORS. Ferrari, A.; Trussoni, E. (Consiglio Nazionale delle Ricerche, Turin (Italy). Lab. di Cosmo-Geofisica). Astrophys. Space Sci.; 33: No. 111-126(Mar 1975).

A detailed analysis is reported of charged particle motion in the e.m. fields generated by oblique magnetic rotators. A full treatment of particle trajectories, radiated power, and spectrum is given; astrophysical implications of these results in connection with pulsars, mainly NP 0532, are discussed and the possibility of a high-energy pulsed radiation model with synchro-Compton emission at the speed-of-light cylinder is investigated. (auth)

4296 MASS OF CYGNUS X-1. Paczynski, B. (Polska Akademia Nauk, Warsaw. Zaklad Astronomii). Astron. Astrophys.; 34: No. 1, 161-162(Aug 1974).

A lower mass limit for Cyg X-1 is obtained as a function of distance under the assumption that HDE 226,868 is not larger than its Roche lobe and noticing that there are no X-ray eclipses, but with no reference to the mass–luminosity relation. At a distance of 2.5 kpc the minimum mass of Cyg X-1 is 9.5 M (solar). If HDE 226,868 is not allowed to be underluminous for its mass, then the distance to the system cannot be much larger than 2 kpc. (auth)

4297 GAMMA-RAY LINES FROM ACCRETING NEUTRON STARS. Reina, C.; Treves, A.; Tarenghi, M. (Milan Univ. (Italy). Istituto di Fisica; Pavia Univ. (Italy). Istituto di Fisica; Consiglio Nazionale delle Ricerche, Milan (Italy). Lab. di Fisica Cosmica e Tecnologie Relative). Astron. Astrophys.; 32: No. 3, 317-320(1974).

The gravitational energy of an ion at the surface of a neutron star is approximately 100 MeV/nucl. Therefore, infalling ions may induce nuclear reactions in the external layer of the star. The γ-ray line emission produced by this process in accreting X-ray sources is evaluated in terms of the X-ray flux, assuming that the infalling matter and the stellar atmosphere have universal abundances. It is found that the most important reactions are inelastic scattering p + He and symmetrically α + H. These interactions lead to two processes yielding γ-rays, a) neutron production and capture by ambient hydrogen with emission of 2.2 MeV photons, b) direct helium excitation giving 22.5 MeV γ-rays. Pair production by these photons and consequent positron annihilation is the most important source of the 0.511 MeV line. (INIS)

4298 WAVE ZONE STRUCTURE OF NP 0532 AND INFRARED RADIATION EXCESS OF CRAB NEBULA. Usov, V. V. (Space Research Institute, Moscow, U.S.S.R.). Astrophys. Space Sci.; 32: No. 2, 375-377(Feb 1975).

At the distance $r \gtrsim 10^{15}$ cm from NP 0532 the plasma concentration decreases so that the intense low-frequency wave (ν = 30 Hz) can propagate. The interaction of this wave with the electrons ejected from the pulsar should result in the ir radiation with $F_\nu \sim 10^2$ fu at $\lambda \sim 10\ \mu$. This flux is the order of the excess ir radiation from the Crab Nebula. (auth)

4299 THE ABSORPTION OF SOFT X-RAYS FROM THE CRAB NEBULA. Iyengar, V. S.; Naranan, S.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay (India)). Astrophys. Space Sci.; 32: No. 2, 431-446(Feb 1975).

The x-ray spectrum of the Crab Nebula has been determined in the energy range 0.5 to 10 keV using thin window proportional counters carried aboard a Centaur IIA rocket launched from TERLS, India. The spectrum can be well represented by a power law with an exponent -2.1 beyond 2 keV. The absorption of the soft x-ray component below 2 keV is clearly seen in the experiment. Attempts to understand quantitatively the spectral features in terms of interstellar absorption lead to a column density of hydrogen in the direction of the Crab Nebula of 3.5×10^{21} H atoms cm^{-2}, if a revised version of the interstellar absorption coefficients of Brown and Gould is adopted to include the contributions of heavier elements, especially of iron. This value of density is a factor of 2 higher than the density obtained from 21 cm radio observations, but falls well within the range of values for atomic and total hydrogen deducible from uv measurements with satellites and the measured visual extinction coefficients for the Crab Nebula. It is concluded that it is not necessary to consider anomalous abundance of elements like carbon or neon either in the source or in the interstellar medium as suggested by some authors. The absorption of x rays in the interstellar dust in the light of current dust models is presented. (auth)

4300 THE VELOCITY OF PULSARS AND INTERSTELLAR IRREGULARITIES IN THE SCINTILLATION PATTERN. Lotova, N. A.; Chashey, I. V. (AN SSSR, Moscow. Fizicheskij Inst.). Astrophys. Space Sci.; 32: No. 2, 331-338(Feb 1975).

The scintillation theory is developed for application to the interstellar medium taking into account both the movement of the pulsars and the movement of the interstellar irregularities. It is shown that the velocity of the drifting pattern differs essentially from that for the pulsars. This difference is due to the medium extent effect and to the motion of the irregularities. The pulsar velocity v_0 and the parameters of the motion of the irregularities ($\overline{V}$,σ) can be derived from the obtained formulae, using the known parameters of the cross-correlation function of scintillations ($\overline{V}_{ef}$, τ_1, S). In contrast with the interplanetary scintillation, the asymmetry of the form of the cross-correlation function of the interstellar scintillations is caused not only by the motion of the interstellar irregularities, but also by the movement of the source itself. (auth)

Solar Phenomena

Refer also to abstracts 4384, 4385, and 4391.

4301 SOLUTION OF THREE-FLUID MODEL EQUATIONS WITH ANOMALOUS TRANSPORT COEFFICIENTS FOR THE QUIET SOLAR WIND. Cuperman, S.; Metzler, N. (CIRES, University of Colorado, and Space Environment Laboratory (SEL) NOAA/ERL, Boulder). Astrophys. J. 196: No. 1, 205-219 (15 Feb 1975).

A three-fluid model consisting of continuity, momentum, and energy equations is used to describe the average behavior of the electrons (e), protons (p), and α-particles (α) in the quiet (undisturbed) expanding solar corona. Friction forces due to the possible occurrence of different e, p, and α streaming velocities are incorporated in the model equations. The transport coefficients are allowed to include (besides collisional interactions) phenomenological contributions from turbulent wave-particle interactions existing in the solar wind. The model assumes spherical symmetry and neglects such effects as viscosity, rotation, and magnetic fields. (However, the inhibition of the heat flux across the interplanetary magnetic field is implicitly taken into account in the expression used for the anomalous thermal conductivity.) The numerical solution of the equations is achieved by using a perturbation-method procedure in

which a two-fluid solution for electrons and protons is followed by a solution for the α-particles. These model-equations predict the following features for the α-particles at 1 a.u.: (i) equal α-particle and proton streaming velocities, (ii) an α-particle to proton temperature ratio of about 3.5, and (iii) an α/p density ratio of about 0.035 (which is also less than half of that in the solar corona). These results explain the α-particle characteristics observed at 1 a.u. (auth)

4302 PHOTOELECTRIC SPECKLE INTERFEROMETRY OF THE SOLAR GRANULATION. Harvey, J.W. (Kitt Peak National Observatory); Schwarzschild, M. Astrophys. J. 196: No. 1, 221-226 (15 Feb 1975).

Using the McMath solar telescope on a morning of average seeing it has been found possible, with the help of photoelectric speckle interferometry, to detect securely the existence of details in the quiet solar granulation up to a wavenumber of 240×10^{-4} km^{-1}, i.e., a wavelength of one-third of an arc second. (auth)

4303 FORBIDDEN LINES OF HIGHLY IONIZED IRON IN SOLAR FLARE SPECTRA. Doschek, G.A.; Feldman, U.; Dere, K.P.; Sandlin, G.D.; VanHoosier, M.E.; Brueckner, G.E.; Purcell, J.D.; Tousey, R. (E. O. Hulburt Center for Space Research, Naval Research Laboratory). Astrophys. J. Lett. 196: No. 2, L83-L86 (1 Mar 1975).

Forbidden lines of Fe XVIII, Fe XIX, and Fe XXI are identified at 974, 1118, and 1354 Å, respectively, in NRL ATM solar flare spectra. These lines are due to magnetic dipole transitions between levels of the ground configurations. The widths of the Fe XIX and Fe XXI lines are ~0.5 A, which is substantially greater than expected in ionization equilibrium. The intensity-time behavior and the widths of these lines are discussed for the 1973 June 15 flare. (auth)

4304 IN SITU OBSERVATIONS OF THE SCALE-SIZE OF PLASMA TURBULENCE IN THE ASTEROID BELT (1.6–3 ASTRONOMICAL UNITS). Intriligator, D.S. (Physics Department, University of Southern California, Los Angeles). Astrophys. J. Lett. 196: No. 2, L87-L90 (1 Mar 1975).

Pioneer 10 observations from the Ames Research Center Plasma Analyzer experiment between 1 and 3 a.u. in 1972 have been used to estimate the power spectra of the streaming speed of solar wind protons. A power-law spectrum is obtained in the $\sim10^{-4}$ to $\sim10^{-3}$ Hz frequency range which is similar to that obtained for the solar wind proton number density and streaming speed at 1 a.u. in 1965 December and 1966 January. The power spectra indicate that significant turbulence on the scale of $\sim10^6$ km or more is present throughout this range of heliocentric distances, implying the importance of the role of large-scale turbulence between 1 and 3 a.u. The power spectra also present qualitatively information concerning the cosmic-ray diffusion tensor at these extended distances. (auth)

4305 ON THE RADIAL VARIATION OF THE INTERPLANETARY MAGNETIC FIELD: PIONEER 6. Villante, U.; Mariani, F. (Istituto Fisico, Università, 67100 L'Aquila, Italy). Geophys. Res. Lett. 2: No. 3, 73-74 (Mar 1975).

Analysis of simultaneous plasma and magnetic field observations by Pioneer 6 suggests, at heliocentric distances of 0.8 to 1.0 AU, significant deviations from Parker's theory: in particular, a radial variation as r^{-2} is estimated for the azimuthal magnetic field component. (auth)

4306 THE GLOBAL SOLAR WIND AND PREDICTIONS FOR PIONEERS 10 AND 11. Suess, S.T.; Nerney, S.F. (Space Environment Laboratory, National Oceanic and Atmospheric Administration, Boulder, Colorado 80302). Geophys. Res. Lett. 2: No. 3, 75-78 (Mar 1975).

The dependence on latitude of the azimuthal component of the interplanetary magnetic field generates a meridional pressure gradient which, in turn, generates a meridional flow. This flow has observable consequences in the equatorial plane, although the meridional velocity itself may be zero in this plane. Analytic estimates of these observables — the mass flux, azimuthal and radial magnetic flux, density, and spiral angle— are made in the range of 1 to 12 AU. (auth)

4307 ELECTRON HEAT FLUX INSTABILITIES IN THE SOLAR WIND. Gary, S.P.; Feldman, W.C.; Forslund, D.W.; Montgomery, M.D. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). Geophys. Res. Lett. 2: No. 3, 79-82 (Mar 1975).

There are at least three plasma instabilities associated with the electron heat flux in the solar wind. This letter reports the study of the unstable fast magnetosonic, Alfvén and whistler modes via a computer code which solves the full electromagnetic, linear, Vlasov dispersion relation. Linear theory demonstrates that both the magnetosonic and Alfvén instabilities are candidates for turbulent limitation of the heat flux in the solar wind at 1 A.U. (auth)

4308 THE RECONNECTION OF MAGNETIC FIELD LINES IN THE SOLAR CORONA. Sheeley, N.R. Jr.; Bohlin, J.D.; Brueckner, G.E.; Purcell, J.D.; Scherrer, V.E.; Tousey, R. (E. O. Hulburt Center for Space Research, Naval Research Laboratory). Astrophys. J. Lett. 196: No. 3, L129-L131 (15 Mar 1975).

Skylab XUV coronal spectroheliograms and photospheric magnetograms are compared. This comparison shows that, as new bipolar magnetic fields emerge through the solar surface into the corona, the new coronal fields interact with the old ones in a manner that suggests the reconnection of the field lines. (auth)

4309 THE EFFECT OF PRIMORDIAL HYDROGEN/HELIUM FRACTIONATION ON THE SOLAR NEUTRINO FLUX. Wheeler, J.C.; Cameron, A.G.W. (Center for Astrophysics, Harvard College Observatory). Astrophys. J. 196: No. 2, 601-605 (1 Mar 1975).

If hydrogen and helium are immiscible below some critical temperature, gravitational separation could occur in the proto-Sun, resulting in a nearly pure helium core and a nearly pure hydrogen shell. We have constructed solar models according to this scenario and find the neutrino flux reduced to 1.5–3 SNU. (auth)

4310 TRANSITIONS $2s^22p^k-2s2p^{k+1}$ OF THE N I AND C I ISOELECTRONIC SEQUENCES. Feldman, U.; Doschek, G.A. (E. O. Hulburt Center for Space Research, Naval Research Laboratory); Cohen, R.D.; Cowan, L. Astrophys. J. 196: No. 2, 613-616 (1 Mar 1975).

Transitions of the type $2s^22p^k-2s2p^{k+1}$ have been identified for the elements from titanium through iron for ions of the nitrogen isoelectronic sequence and for the elements titanium through nickel for ions of the carbon isoelectronic sequence. Wavelengths, intensity estimates and energies are given. The lines were identified from isoelectronic sequence. Wavelengths, intensity estimates and energies are given. The lines were identified from EUV spectra obtained from laser-produced plasmas. The energy differences of levels of the ground configuration for the C I isoelectronic sequence are compared with extrapolations based on semiempirical equations derived Edlén. Wavelengths of forbidden Fe XXI lines that can be seen in low-density plasmas such as solar flare plasmas are predicted. The laser plasma spectrum is briefly compared with available solar flare spectra. (auth)

4311 THE COMPTON EFFECT IN THE CHROMOSPHERE. Missana, M. (Oxford Univ. (UK). Dept. of Astrophysics). Astrophys. Space Sci.; 33: No. 1, 239-243(Mar 1975).

It is assumed that the lines of the solar spectrum, formed in the reversing layer, when travelling from an optical thickness τ in the chromosphere are subjected to a redshift $\Delta\lambda(\tau)$ due to multiple Compton scattering. The investigation is limited to the difference of the redshift at the limb- the redshift at the centre of the disc giving a good agreement between the theoretical results and observations. (auth)

4312 CRITERION FOR PROPAGATION OF MAGNETOHYDRODYNAMIC WAVES: AN EQUIVALENCE. De, B. R. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Astrophys. Space Sci.; 33: No. 235-237 (Mar 1975).

It is shown that the requirement that a magnetohydrodynamic wave propagate over a distance equal to a large number of wavelengths without substantial attenuation is equivalent to the requirement that the lateral velocity of displacement of the field lines far exceed a characteristic velocity. This latter velocity is the velocity of slippage of the field lines with respect to the medium. (auth)

4313 AN ARGUMENT AGAINST A TYPE I COMETARY TAIL MODEL. Wurm, K. (Asiago Observatory, Italy). Astrophys. Space Sci.; 32: No. 2, L19-L23(Feb 1975).

This letter represents an abstract of a forthcoming publication in which a type I cometary tail model is explained in terms of observational facts without additional assumptions. It is made clear that essential claims and assertions of the currently discussed magnetohydrodynamical theory of the tails cannot be brought into agreement with this "experimental" model. (auth)

4314 SOLAR–TERRESTRIAL DISTURBANCES OF AUGUST 1972. Part IV. Solar X-Ray Flares and Their Corresponding Sudden Ionospheric Disturbances. Ohshio, M. (Radio Research Lab., Koganei, Tokyo). Denpa Kenkyusho Kiho; 19: No. 103, 261-280(Jul 1973). (In Japanese).

Four solar x-ray flares which occurred at the first decade of August 1972 were large, the size being inferred from sudden ionospheric disturbances caused by the said flares. The time variations of the solar x-ray flux intensity observed could not be obtained at the maximum stage of these four events owing to the artificial satellite eclipse and/or the saturation of the detector. Both estimations from extrapolation in the shape of the time variation and from the maximum phase deviation of the normalized sudden phase anomaly (SPA) observed show that the maximum solar x-ray (1 ~ 8Å) flare flux intensities or the maximum enhanced ones for August 4 and 7 were so large as to exceed 1 erg cm^{-2} s^{-1}. Their decreasing stages were so long as to last more than half a day. The use of a flare model valid for the arrival of solar ionizing agents of the largest class during the pertinent period has shown that the enhanced electron density in the ionosphere is larger than the quiet one by about two orders at an altitude of 70 km and by 2 to 1 times at an altitude of 90 to 120 km. It is supposed that in these four events, particularly August 4 and 7 events, solar ex-

treme ultraviolet ray flares also occurred to cause all kinds of sudden ionospheric disturbances with their largest scale. (auth)

4315 SOLAR–TERRESTRIAL DISTURBANCES OF AUGUST 1972. Part II. Developments of Solar Active Regions. Maeda, R.; Inuki, H. (Radio Research Lab., Nakaminato, Ibaraki, Japan). Denpa Kenkyusho Kiho; 19: No. 103, 247-254(Jul 1973). (In Japanese).

This report describes mainly the outline of the development of the 11976 region. From late July to early August, 1972, several sunspot groups were found on the solar disc. Among them the 11976 group was the most active, extending for about 10 degrees north–south and about 20 degrees east–west in the maximum stage. Many remarkable solar events originated almost in the active region, which had formed magnetically a positive peninsula or a positive island bounded by steep cliffs drowned into negative seas on magnetic configurations of the photosphere. The boundaries between the positive and the negative domains, that is, the neighborhood of magnetic neutral lines, generated the unstable zones from which major flares were frequently ejected. (auth)

4316 SPICULES AND THEIR SURROUNDINGS. Michard, R. (Observatoire de Paris, Section de Meudon, 92 (France)). pp 3-21 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Spicules show an intrinsic dispersion in all parameters that can be individually measured notably in the source functions for Balmer lines emission. These fluctuations are related to height in the chromosphere, and most likely also to phase in the evolution of these features. In the spicules there is a predominant bulk motion along the axis, which is ascending during the first phase in the life of each feature, then stops and eventually reverses. Spicules are denser than their immediate surroundings at all heights. They are also most likely colder at heights greater than some unknown level, and possibly hotter below this level. However the height where the spicules start is uncertain between 0 and 2000 km. Models in which spicules start where the chromosphere ceases to be roughly isothermal are not excluded. Spicules cluster in "coarse mottles" forming a "coarse network", delineating the boundaries of supergranules (BSG regions). The surroundings of spicules are thus somewhat special regions of the chromosphere with enhanced emission in many lines such as center of HαK line, Ly-α, and xuv lines characteristics of transition to coronal temperatures, as shown by OSO-4 and -6 data. The coarse mottles are coincident with enhanced magnetic fields, and there is a nearly continuous sequence of situations between the quiet Sun coarse mottles, and the plages of active regions. (auth)

4317 RECENT DEVELOPMENTS IN IMPROVING DAYTIME ANGULAR RESOLUTION FROM THE GROUND. Kiepenheuer, K. O. (Fraunhofer Institut, Freiburg, F. R. Germany). pp 27-30 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

There are large "windows" of excellent seeing in the atmosphere. They occur above 2000 m altitude above the ocean and will guarantee for long periods an image quality as obtained with balloon-borne equipment in the stratosphere, probably even better than this, if larger instruments can be used. These large "windows", however, shrink to bull's eyes if a direct optical access to the stable airmass on the ground or in buildable heights above the ground is wanted, because then the complicated condition of laminar airflow and absence (or wiping off) of the thermal convection has to be fullfilled. Indeed, such windows are extremely rare. But they do exist and the corresponding sites will very probably enable the solar scale height to be resolved from the ground in pictures as well as in long exposure spectrograms during long periods of time. The residual inhomogeneities which could be traced even high above the ocean in a stable airmass (Clear Air Turbulence) by aircraft and by free flying balloons turned out to be mostly so small that their optical effects along the line of sight are on the average important only for very large solar telescopes (aperture $\gtrsim$ 150 cm). (auth)

4318 WHY THE CHROMOSPHERE HAS ITS DISCRETE FINE STRUCTURE. Schmidt, H. U. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)). pp 35-44 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

The fine structure in the chromosphere is probably controlled by magnetic flux concentrations which cellular convection produces in the photosphere. This flux concentration by the convection and its constraints are considered, and the chromospheric network and its main constituent, the spicules, are discussed. The inside of the network, i.e., the fibrils, are considered. (auth)

4319 COMPARISON OF Hα AND Ca II H AND K SPECTROHELIOGRAMS AS A DIAGNOSTIC PROBE. Gebbie, K. B.; Steinitz, R. (Colorado Univ , Boulder (USA)). pp 55-63 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

The line formations of Hα and Ca II H and K are compared in order to differentiate the various mechanisms giving rise to observable contrasts in the emergent intensities. The criteria for distinguishing between horizontal spatial variations in temperature, density, and turbulent velocity are summarized. (auth)

4320 FINE STRUCTURE OF THE UPPER CHROMOSPHERE. Jefferies, J. T. (Hawaii Univ., Honolulu (USA)). pp 71-88 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I. A. U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

The paper contains a review of attempts to understand observational data on the inhomogeneous structure of the upper solar chromosphere, particularly the spicules. Observations over the electromagnetic spectrum from millimetric to the ultraviolet give equivocal results; and in spite of recent progress, models for these inhomogeneous structures still face difficulties in accounting for the observed radiation. New observations in the visible are needed in order to answer even the simplest questions of kinematics, while the interpretation of the line spectra still poses many difficulties. The acquisition of euv data at high spatial resolution should lead to major progress in the field, just as it already has done in showing the uev emission to be concentrated over the network boundaries. (auth)

4321 MOTIONS OF CHROMOSPHERIC FINE STRUCTURES. Frazier, E. N. (Aerospace Corp., Los Angeles, Calif. (USA)). pp 97-135 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

This review concerns itself with the measurement of the effects of chromospheric motions and the diagnosis of those motions themselves over approximately the last ten years. The different types of observational techniques are described. The different size regimes of motions are reviewed and their possible effects on observable quantities are discussed. The different types of motion in the lower chromosphere are reviewed, including microturbulence, "layered" motions, and observations and interpretation of asymmetries in the core of the Ca II K line. The observation of motions in H mottles on the disk and spicules on the limb are reviewed, from the standpoint of both line profile analysis and broadband measurements. The interpretation of these motions and attempts to construct empirical models of chromospheric fine structures are discussed. (auth)

4322 WAVES AND OSCILLATIONS IN THE CHROMOSPHERE IN ACTIVE AND QUIET REGIONS. Giovanelli, R. G. (National Standards Lab., Sydney (Australia)). pp 137-151 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I. A. U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Oscillations and waves have been observed in Hα in sunspot umbras and penumbras. They appear to be basically of the Alfvén type, but do not carry away sufficient energy to account for the sunspot energy deficit. There is a pronounced difference in the velocity structures of supergranule centres and boundaries. In the former it is oscillatory, of shorter period but bigger amplitude than in the photosphere. In the network there are oscillations of the fibrils but, on the whole, little evidence of wave motion along their lengths except perhaps near their diffuse ends. In plages, there are velocity oscillations which at times may be phase co-

herent over extensive regions up to 10^5 km apart; there are suggestions of a connection between these times and the occurrence of flares. There is also a report of a velocity pulse travelling along an active-region fibril with a velocity of propagation of 150 km s^{-1}. (auth)

4323 THE MAGNETIC STRUCTURE OF PLAGES. Zirin, H. (Hale Observatories, Pasadena, Calif. (USA)). pp 161-175 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Study of plage structure shows the following points: (1) Plages emerge in the interior of emerging flux loops. (2) Complexity is only produced by the emergence of new flux loops. (3) There is no twist in the emerging loops. (4) There are no spicules over plages. (5) The plage structures are long lived. (6) The magnetic structure of plages is quite shallow. (7) The brightness of plages is uniquely determined by the magnetic field structure. (auth)

4324 THE RELATION BETWEEN CHROMOSPHERIC AND PHOTOSPHERIC STRUCTURES IN SUNSPOT GROUPS. Bumba, V.; Ambroz, P. (Ceskoslovenska Akademie Ved, Ondrejov. Astronomicky Ustav). pp 183-191 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Using the high-resolution photographs of the photosphere taken at the Ondrejov observatory a comparison of positions and forms of some chromospheric features with the distribution of photospheric fine structure morphological elements in the August 1972 active region has been made. The close relationship between active filaments, chromospheric threads, fibrils and photospheric small nuclei, dark interpenumbral and intergranular spaces or rudimentry penumbra is shown. Some considerations are demonstrated with the aid of computer models of the horizontal component of the magnetic vector simulating the real distribution of magnetic fields in the studied region. (auth)

4325 STREAMING MAGNETIC FEATURES NEAR SUNSPOTS. Vrabec, D. (Aerospace Corp., Los Angeles, Calif. (USA)). pp 201-231 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Observations prompted by Sheeley's discovery of outflowing CN bright points from sunspots have established that there occur small moving magnetic features (MMF's) near sunspots. These MMF's exhibit a highly ordered pattern of movement directly related to the associated sunspot. The observations are consistent with the concept of magnetic flux outflow (MFO), a process whereby net magnetic flux of the same polarity as the sunspot is transferred from a decaying sunspot to the surrounding magnetic network. Small magnetic flux concentrations are apparently convected outward by a velocity cell centered on the sunspot. Doppler spectroheliograms have provided evidence for such systematic outward velocities extending as far as 10,000 to 20,000 km beyond the outer edge of the penumbra of some sunspots, which is comparable to the extent of MFO. While MFO is best observed by means of time-lapse movies of the magnetic fields, it is also manifested morphologically on individual magnetograms by features that resemble moats (or bays) and wreaths around only those sunspots where MFO is present. Two examples of magnetic features streaming toward and into rapidly forming sunspots are described, providing evidence for the occurrence of magnetic flux inflow (MFI) associated with the growth phase of sunspot development. It is, therefore, likely that MFI and MFO are basic aspects of the evolutionary development of sunspots. Observational and instrumental aspects relevant to the investigation of MMF's are described. (auth)

4326 EVOLUTION OF CHROMOSPHERIC FINE STRUCTURES ON THE DISK. Tanaka, K. (Tokyo Astronomical Observatory, Mitaka, Tokyo, Japan). pp 239-255 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Evolution of chromospheric fine structures is discussed from observational points of view. First, various lifetime determinations are reviewed. Then chromospheric oscillation in the interior of supergranule cell is discussed in relation to chromospheric "grain" structure. It is shown that the grains are collectively associated with the 180-s oscillations as well as that in K line the grain is identified with local disturbance generated at lower levels and propagating to upper levels. Finally the details of evolution of individual mottles are presented. Some cases are shown which indicate the propagation of a disturbance along the mottle axis. Statistics of evolution patterns of mottles implies a significant tendency for a system of double dark mottles encasing a bright mottle. (auth)

4327 EVOLUTION OF STRUCTURES IN THE BRIGHT Hα NETWORK. Dravins, D. (Lund Observatory, Lund, Sweden). pp 257-261 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

Off-band Hα filtergrams are presented showing the bright Hα network (solar filigree) and its evolution, with subarcsecond resolution. In quiet regions the total area covered by elements in the network is constant over periods of hours but changes in the geometry are observed over 10 min (the timescale of granule and dark mottle lifetimes), that can be interpreted as due to (macro) turbulent horizontal velocities of about 1 km s^{-1}. The network can be resolved into strings of tiny bright dots; on the order of 100 per supergranule cell boundary. These dots may mark the location of magnetic filaments. The contrast of the features is higher in the blue than in the red wing which may indicate that in the lower chromosphere, the downdraft at supergranule boundaries does not occur in the bright crinkles themselves but rather adjacent to them. (auth)

4328 THE CHROMOSPHERIC ENERGY BALANCE. Piddington, J. H. (National Standards Lab., Sydney (Australia)). pp 269-291 of Chromospheric Fine Structure. Proceedings of the International Astronomical Union Symposium No. 56 Held at Surfer's Paradise, Queensland, Australia, 3-7 Sep 1973. Athay, R. G. (ed.). Dordrecht, Netherlands; Reidel (1974).

From I.A.U. symposium No. 56 on chromospheric fine structure; Surfer's Paradise, Queensland, Australia (3 Sep 1973).

The problem of the solar atmospheric heat and energy balances is here divided into three sections. (i) Basically the problem is an outward temperature gradient involving additional radiation losses whose estimate involves a model atmosphere. Proposed models described are based on optical and radio emissions together with various theoretical considerations such as thermal conductivity. The models are useful in providing estimates of the required flux of mechanical energy from below. However, they are limited by the use of averaging processes, and the failure to take full account of the many structural features which make up the chromosphere. (ii) It has long been accepted that the main energy input is by acoustic waves generated in the "small-bubble" Vitense model convection zone. Recent observations of chromospheric magnetic and velocity fields and their interpretation are reviewed which strongly suggest that this model is not valid and that the acoustic theory of heating is without basis. At the same time the new data remove the objections of Osterbrock and others to a theory of heating based on Alfvén and/or slow-mode hydromagnetic waves. (iii) Observations of a variety of individual magnetic-plasma chromospheric structures, together with the adoption of heating by waves which follow the field lines, suggest a new approach to the whole problem of the heat balance. The heating problem is discussed in a number of these magnetic-plasma structures including the emission network, spicules and related disk features, arch filament systems and flares. (auth)

Galaxies

Refer also to abstracts 4195, 4214, 4246, 4273, and 4499

4329 OBSERVATIONAL PROBLEMS OF HIGH ENERGY ASTROPHYSICS. Burbidge, E. M. (Univ. of California, San Diego). pp 109-172 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

A lecture is given primarily on normal and abnormal galaxies, quasi-stellar objects, and the intergalactic medium. (JFP)

4330 STRUCTURE AND DYNAMICS OF GALAXIES. Prendergast, K. H. (Columbia Univ., NY). pp 415-439 of High Energy Astrophysics and Its Relation to Elementary Particle Physics.

Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on structure and dynamics of galaxies includes a description of a "normal" galaxy and the analytical form of the distribution function. (JFP)

4331 THE DIFFUSE INTERSTELLAR BANDS. IV. THE REGION 4400–6850 Å. Herbig, G.H. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 196: No. 1, 129-160 (15 Feb 1975).

Between 4400 and 6850 Å a total of 39 diffuse absorption features are described which are certainly or probably of interstellar origin, together with seven more which also may qualify. Equivalent widths of the 17 bands for which the data are most extensive correlate well ($r \simeq 0.9$) with $E(B-V)$, but even better with $E(V-I)$ and other long-wavelength indices which avoid the bend near 4400 Å in the interstellar extinction curve. The internal correlation of one line with another is in most cases excellent. Regional effects worsen the general correlation with color excess; the most conspicuous discrepancies are in Cyg and Sco-Oph where the band strength per unit color excess is 30 percent lower than elsewhere. Empirical wavelengths established for the narrower diffuse lines make possible comparison with multiple atomic interstellar lines in the same spectra to an accuracy of about 1 km s^{-1}. The presence of the diffuse lines bears no demonstrated relationship to the type of background star given an adequate amount of extinction: they are seen from type O to at least mid-G and in novae. No support is seen for identification of the minima in Type I supernova spectra with the diffuse interstellar bands. Study of the wavenumbers of the many diffuse lines now known has still not led to identification of the carrier. Arguments are presented that the material is not in the gas, but is a constituent of the very small grains (radius $\simeq$300 Å) which are believed responsible for the far-ultraviolet extinction. The diffuse-line spectrum can thus properly be considered as fine structure in the interstellar extinction curve. On this basis, a semitheoretical explanation is advanced for the observed correlation between band strength per unit color excess and the degree of curvature at 4400 Å, in terms of the absorptivity $\lambda > 4400$ Å of the grains and the relative numbers of large and small particles, considered as Mie spheres. The diffuse bands have not been found in either absorption or emission in dusty solar system objects; it is pointed out that if their breadth is due to predissociation of the upper levels, then there is little hope that they will be detectable in emission in comets or reflection nebulae. (auth)

4332 DETECTION OF GIANT DUST COMPLEXES IN THE DIRECTION OF NGC 7538 IN THE PERSEUS ARM. Minn, Y.K. (The University of Alabama); Greenberg, J.M. Astrophys. J. 196: No. 1, 161-165 (15 Feb 1975).

We have found a giant dust region in the Perseus arm, in the direction of NGC 7538, which contains three large dust complexes. These complexes are not apparent optically as dark clouds but are detected by 6-cm H_2CO absorption. The overall angular dimension of the region is about $50' \times 15'$, and the velocities are in the range -50 to -55 km s^{-1}. The observed H_2CO lines have unusually large line widths. The increase of the line widths toward the complex centers may indicate a state of contraction. The velocity gradient within each complex is very small. A small decrease of H I intensity at the position and velocity of the complexes is found. The derived column density of H_2CO for the largest complex is 1.99×10^{14} cm^{-2} and the total mass deduced is of the order of, or greater than, 10^5 $M_\odot$. (auth)

4333 RADIO RECOMBINATION LINE OBSERVATIONS OF THE C II REGION NGC 2023. Knapp, G.R. (Owens Valley Radio Observatory, California Institute of Technology); Brown, R.L.; Kuiper, T.B.H. Astrophys. J. 196: No. 1, 167-177 (15 Feb 1975).

The reflection nebula NGC 2023 has been observed at four frequencies in a study of its carbon recombination line emission. The observations show the recombination line region to be about 2 pc in diameter, with an average electron density of $\sim$0.2 cm^{-3} and electron temperature of $\sim 20°$ K. The electron density increases exponentially near the B1.5 star HD 37903, the illuminating star of NGC 2023. The most reasonable interpretation of the observational results is that the carbon emission lines arise in a cold C II region surrounding HD 37903. The coexistence of the C II region with a region of enhanced CO emission suggests that the CO in NGC 2023 may be excited by electron collisions. (auth)

4334 THE OPTICAL SPECTRUM OF THE NEBULA YM 29. Leibowitz, E.M. (Department of Physics and Astronomy). Astrophys. J. 196: No. 1, 191-194 (15 Feb 1975).

New spectrograms of the nebula YM 29 lend some support to the identification of this object as a low-excitation planetary nebula. The abundances of oxygen, nitrogen, and probably sulfur in this nebula are close to the mean values for these elements in planetary nebulae. (auth)

4335 ON THE MASSES AND RELATIVE VELOCITIES OF GALAXIES. Burbidge, G. (Department of Physics, University of California, San Diego). Astrophys. J. Lett. 196: No. 1, L7-L10 (15 Feb 1975).

Contrary to the results obtained by Einasto *et al.* and Ostriker *et al.*, we show that there is no unambiguous dynamical evidence which demonstrates that galaxies have very massive halos. For our own Galaxy an upper limit to the mass of $\sim 2 \times 10^{11}$ $M_\odot$ out to $\sim$ 70 kpc is set, following the work of Hodge, by two dwarf ellipticals, the Draco and Sculptor systems. The result that $M(R) \propto R$ suggested by Ostriker *et al.* is entirely dependent on the assumptions (*a*) that all systems studied are physical systems, and (*b*) that they are bound. In many cases these assumptions are in doubt. It is shown that the scale of internal velocities in galaxies and relative velocities between galaxies is remarkably constant with a radial component $\sim$300 km s^{-1}. Significantly larger values of this quantity are only found in rich clusters of galaxies. (auth)

4336 FAR-INFRARED OBSERVATIONS OF W51 WITH HIGH SPATIAL RESOLUTION. Harvey, P.M.; Hoffmann, W.F.; Campbell, M.F. (Steward Observatory, University of Arizona). Astrophys. J. Lett. 196: No. 1, L31-L34 (15 Feb 1975).

Observations of the core of W51 have been made from the NASA C-141 Airborne Infrared Observatory at 55 μ with 17", 35", and 85" apertures and at 100 μ with a 35" aperture. These observations suggest the presence of a small ($\lesssim 20$") source at 55 μ surrounded by a much broader diffuse background. In the center of the source the optical depth at 55 and 100 μ is on the order of 0.1–0.2. (auth)

4337 OBSERVATIONS OF THE $J = 2 \rightarrow 1$ TRANSITION OF CARBON MONOXIDE IN INTERSTELLAR CLOUDS. Goldsmith, P.F.; Plambeck, R.L. (Department of Physics and Radio Astronomy Laboratory, University of California at Berkeley); Chiao, R.Y. Astrophys. J. Lett. 196: No. 1, L39-L42 (15 Feb 1975).

We have observed the $J = 2 \rightarrow 1$ rotational transitions ($\lambda = 1.3$ mm) of ^{12}CO and ^{13}CO in a number of dense molecular clouds associated with H II regions. The intensities of the $J = 2 \rightarrow 1$ lines are roughly equal to the intensities previously measured for the $J = 1 \rightarrow 0$ transition. The velocities and line widths of the $J = 2 \rightarrow 1$ and $J = 1 \rightarrow 0$ transitions are in close agreement. We find that the ^{13}CO $J = 2 \rightarrow 1$ line is optically thick in these sources. (auth)

4338 HYDROMAGNETIC WAVES IN MOLECULAR CLOUDS. Arons, J. (Department of Astronomy, University of California, Berkeley); Max, C.E. Astrophys. J. Lett. 196: No. 2, L77-L81 (1 Mar 1975).

We suggest that the observed large widths of CO emission lines may be due to the presence of moderate-amplitude hydromagnetic waves in molecular clouds. For parameters typical of CO emitting regions, this hypothesis is viable if such clouds contain systematic magnetic fields of strength $B_0 \gtrsim 40$ microgauss. The damping rate of the waves is discussed, as is the energy required if the observed line widths are due to hydromagnetic waves. To illustrate how wave energy may be supplied, a simple model is outlined for the emission of magnetoacoustic waves by *H* II regions embedded in magnetized molecular clouds. (auth)

4339 THE VELOCITY DISPERSION OF THE CLUSTER OF GALAXIES ABELL 1060 (3*U* 1044–30). Vidal, N.V.; Peterson, B.A. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, Australian University). Astrophys. J. Lett. 196: No. 3, L95-L97 (15 Mar 1975).

Radial velocity measurements of 15 galaxies in the cluster A1060 give an average velocity of 3233 km s^{-1} and a dispersion velocity of 799 km s^{-1}. The X-ray luminosity is 1.5×10^{43} ergs s^{-1}. The correlation of velocity dispersion and X-ray luminosity is reviewed. (auth)

4340 DETECTION OF INTERSTELLAR TRANS-ETHYL ALCOHOL. Zuckerman, B. (University of Maryland); Turner, B.E.; Johnson, D.R.; Clark, F.O.; Lovas, F.J.; Fourikis, N.; Palmer, P.; Morris, M.; Lilley, A.E.; Ball, J.A.; Gottlieb, C.A.; Litvak, M.M.; Penfield, H. Astrophys. J. Lett. 196: No. 3, L99-L102 (15 Mar 1975).

Three transitions of *trans*-ethyl alcohol (CH_3CH_2OH) were detected in emission toward the Sagittarius *B2* molecular cloud. The $6_{06} - 5_{15}$ transition at 85,265.46 MHz, the 4_{14}-3_{03} transition at 90,117.51 MHz, and the $5_{15} - 4_{04}$ transition at 104,808.58 MHz were observed at $V_{lsr} \sim 60$ km s^{-1}. The abundance of ethyl alcohol in the Sgr B2 cloud is comparable to that of many molecules previously detected there. Careful comparison of the abundance of ethyl alcohol with chemically related molecules such as its isomer dimethyl ether, acetaldehyde, and methyl alcohol may provide important information about mechanisms for molecular formation in the interstellar medium. (auth)

4341 THE INTERSTELLAR MEDIUM NEAR THE SUN: THE LINE OF SIGHT TO LAMBDA SCORPII. York, D.G. (Princeton University Observatory). Astrophys. J. Lett. 196: No. 3, L103-L106 (15 Mar 1975).

A preliminary analysis of the column densities and ionization structure in the line of sight to λ Scorpii shows that at least three, and possibly four, regions can be identified by physical properties or by velocity separation in the line profiles. These include a region near $T = 2 \times 10^{5}$°K, containing the O VI lines; one or more H II regions; and an H I region, which, however, may contain some S III and C III. Two weak lines of molecular hydrogen are detected, but their

velocities are not consistent with their being in the H I region. The abundances of the elements in the H I region show a depletion pattern quite similar to, though somewhat less pronounced than, that found by Morton for the line of sight to ζ Oph. (auth)

4342 STATISTICAL ANALYSIS OF CATALOGS OF EXTRAGALACTIC OBJECTS. VI. THE GALAXY DISTRIBUTION IN THE JAGELLONIAN FIELD. Peebles, P.J.E. (Physics Department, Universtiy of California, Berkeley). Astrophys. J. 196: No. 2, 647-651 (1 Mar 1975).

The Jagellonian catalog lists more than 10,000 galaxies in a $6°\times6°$ area. Estimates of the two-point and three-point correlation functions for the distribution are presented. The results for both functions agree very well with the correlation functions derived from the Zwicky catalog of galaxies and scaled to take account of the greater depth in the Jagellonian survey. (auth)

4343 VALENCE EXCITED STATES OF CH. III. RADIATIVE LIFETIMES. Hinze, J.; Lie, G.C. (Department of Chemistry, The University of Chicago); Liu, B. Astrophys. J. 196: No. 2, 621-631 (1 Mar 1975).

Theoretical calculations on transition probabilities between low-lying states of CH, using accurate ab initio electronic wave functions, have yielded radiative lifetimes for the $v=0$ vibrational levels of the $A^2\Delta$, $B^2\Sigma^-$, and $C^2\Sigma^+$ states of 388, 260, and 89 ns, respectively. These results are expected to be accurate within ±15 percent. Based on these theoretical results, an effort has been made to assess the validity of available experimental data. (auth)

4344 STARLIGHT EXCITATION OF PERMITTED LINES IN THE ORION NEBULA. Grandi, S.A. (Steward Observatory, University of Arizona). Astrophys. J. 196: No. 2, 465-472 (1 Mar 1975).

From an idealized model of the Orion Nebula and from an analysis of line ratios it is shown that direct starlight excitation of the permitted O I line dominates over recombination and Lyman line fluorescence. The line strengths predicted by this mechanism agree reasonably well with those observed in the Orion Nebula. The application of direct starlight excitation to other ions is also discussed. (auth)

4345 THE STRUCTURE OF THE ORION A MOLECULAR CLOUD. Gerola, H.; Sofia, S. (Joint Institute for Laboratory Astrophysics, University of Colorado). Astrophys. J. 196: No. 2, 473-478 (1 Mar 1975).

A consistent model of the Orion A molecular cloud is obtained by making use of the observed brightness temperature distributions of the $J=2\rightarrow1$ and the $J=1\rightarrow0$ transitions of the CO molecule, and the central component ($F=2\rightarrow1$) of the $J=1\rightarrow0$ transition of HCN, as well as the observed line profiles of the $J=2\rightarrow1$ transition of CO, and the $J=1\rightarrow0$ transition of HCN. The modeling is accomplished by fitting simultaneously all of these observations through solutions of the coupled equations of statistical equilibrium and radiative transfer for a spherical cloud having a kinetic temperature gradient, and different density and velocity distributions. We find that Orion A is strongly gravitationally bound and contracting, and that it can maintain the observed temperature distribution only by virtue of internal energy sources other than the contraction. This last conclusion is reached by computing the radiative losses due to the CO and HD cooling, as well as the losses due to inelastic collisions between the gas and the dust. Our results show that while the contraction rate is just about sufficient to balance the rate of radiation by CO, it is less than one-tenth of the rate at which energy is radiated by HD, and less than 0.001 of that at which energy could be lost to cool grains through totally inelastic collisions. (auth)

4346 INTERSTELLAR H_2CO. I. ABSORPTION STUDIES, DARK CLOUDS, AND THE COSMIC BACKGROUND RADIATION. Evans, N.J. II (University of California, Berkeley); Zuckerman, B.; Morris, G.; Sato, T. Astrophys. J. 196: No. 2, 433-456 (1 Mar 1975).

The $2_{11}\leftrightarrow2_{12}$ transition at 2-cm wavelength of interstellar formaldehyde has been observed in absorption against galactic continuum sources and the 2.7°K cosmic background radiation. In addition, the $1_{10}\leftrightarrow1_{11}$ transition at 6-cm wavelength of the rare isotopic species $H_2{}^{13}C^{16}O$ has been detected in absorption against the cosmic background radiation in at least two clouds. These observations are used to distinguish among the various models for cooling the 6-cm doublet of $H_2{}^{13}C^{16}O$ below 2.7°K, and a collisional pumping model is found to be in the best agreement with the observations. In the dark clouds that display this cooling, calculations indicate that the H_2 densities are between 10^3 and 10^4 cm^{-3}, $n_e/n_{H2}\lesssim10^{-5}$, and the value of $H_2{}^{13}C^{16}O/H_2{}^{12}C^{16}O$ is similar to the terrestrial $^{12}C/^{13}C$ ratio. Estimates of the H_2CO/H_2 ratio in several diverse clouds indicate values of the order of $2\text{–}4\times10^{-9}$. Observations toward Cas A indicate that the temperature of the cosmic background radiation at 2-mm wavelength is $\lesssim2.9$°K. (auth)

4347 DENSITY WAVE THEORY AND THE CLASSIFICATION OF SPIRAL GALAXIES. Roberts, W.W. Jr. (University of Virginia); Roberts, M.S.; Shu, F.H. Astrophys. J. 196: No. 2, 381-405 (1 Mar 1975).

Axisymmetric models of disk galaxies taken together with the density wave theory allow us to distinguish and categorize spiral galaxies by means of two fundamental galactic parameters: the total mass of the galaxy, divided by a characteristic dimension; and the degree of concentration of mass toward the galactic center. These two parameters govern the strength of the galactic shocks in the interstellar gas and the geometry of the spiral wave pattern. In turn, the shock strength and the theoretical pitch angle of the spiral arms play a major role in determining the degree of development of spiral structure in a galaxy and its Hubble type. The application of these results to 24 external galaxies demonstrates that the categorization of galaxies according to this theoretical framework correlates well with the accepted classification of these galaxies within the observed sequences of luminosity class and Hubble type. (auth)

4348 THE FORMATION OF THE NUCLEI OF GALAXIES. I. M31. Tremaine, S.D. (Joseph Henry Laboratories, Physics Department, Princeton University); Ostriker, J.P.; Spitzer, L. Jr. Astrophys. J. 196: No. 2, 407-411 (1 Mar 1975).

Globular clusters passing near the center of M31 interact with the background stars through dynamical friction and spiral to the center of the galaxy, where they are tidally disrupted by interactions with the growing nucleus. By this process a distinct high-density central nucleus of mass $\sim5\times10^7\,M_\odot$ will be formed in 10^{10} years. These predictions are consistent with recent Stratoscope balloon observations of the nucleus of M31. (auth)

4349 ON THE "SEYFERT SEXTET" VV 115. Chincarini, G. (McDonald Observatory, University of Texas); Martins, D. Astrophys. J. 196: No. 2, 335-337 (1 Mar 1975).

Radial velocities in a field east of the Seyfert Sextet indicate that the Seyfert's compact group is a condensation in an extended group of galaxies. (auth)

4350 A RADIO SURVEY OF MARKARIAN GALAXIES AT 6 CENTIMETERS. Sramek, R.A. (National Radio Astronomy Observatory,* Green Bank, West Virginia); Tovmassian, H.M. Astrophys. J. 196: No. 2, 339-345 (1 Mar 1975).

All 506 galaxies in Markarian's first five lists were surveyed at 6 cm wavelength with a 3 σ detection limit of about 30 mJy. Twenty-eight galaxies were detected. The Markarian galaxies with Seyfert characteristics have higher radio luminosities. Among these, radio emission is predominantly detected from galaxies of color type II and from those having the more diffuse d nuclei. Among the non-Seyfert Markarian galaxies, those without any spectral lines are more often detected, and these tend to have the more condensed s-type nuclei. There is a tendency for galaxies which are double, or which have ejections, tails, or some form of optical peculiarity, to also have detectable radio emission. (auth)

4351 MILLIMETER-WAVE OBSERVATIONS OF ELLIPTICAL GALAXIES. Heeschen, D.S.; Conklin, E.K. (National Radio Astronomy Observatory). Astrophys. J. 196: No. 2, 347-349 (1 Mar 1975).

Millimeter-wavelength observations of elliptical galaxies are described. At least one of the galaxies is variable, on a time scale of the order of a year. (auth)

4352 STEPS TOWARD THE HUBBLE CONSTANT. V. THE HUBBLE CONSTANT FROM NEARBY GALAXIES AND THE REGULARITY OF THE LOCAL VELOCITY FIELD. Sandage, A.; Tammann, G.A. (Hale Observatories, Carnegie Institution of Washington, California Institute of Technology). Astrophys. J. 196: No. 2, 313-328 (1 Mar 1975).

Distances to very nearby bright spiral galaxies from Paper IV are combined with individual redshifts to obtain the mean local Hubble expansion rate of $H_0=57\pm3$ km s^{-1} Mpc^{-1}. This is the same as $H_0=57\pm6$ km s^{-1} Mpc^{-1} from the Virgo cluster alone ($D\simeq20$ Mpc) found in Paper IV, and is also closely the same as the global value of $H_0=55\pm6$ km s^{-1} Mpc^{-1} found from remote Sc I galaxies ($D\gtrsim60$ Mpc, $v_0\gtrsim3000$ km s^{-1}) in Paper VI. The agreement of the three rates shows that there is no measurable velocity anisotropy in the *mean* velocity field of nearby spiral galaxies, and further that there is no systematic variation of the Hubble constant with distance. This is the same result as obtained earlier by Sandage, Tammann, and Hardy in 1972, using the nearer clusters and groups of E galaxies. To investigate further, the sample is increased by using luminosity-class distances to Sc I, Sc II, and Sc III galaxies classified by van den Bergh in the north and by us in the south. A bias is identified, and the sample is cut to 71 objects to form a distance-limited list. The mean Hubble rate for these is found to be the same in the hemisphere toward and away from the Virgo cluster to within 1 σ of the combined errors, despite the large density contrast of the Coma-Virgo complex. A more refined analysis fails to isolate any periodicities in the Hubble ratio (v_r/r) along the supergalactic equator that are significant at the 3 σ level. The data in our unbiased sample also give the same Hubble rate (to within the combined errors) in the two areas where Rubin and Ford had previously suggested that a significant anisotropy exists in the local expansion rate. An upper limit to the mean random motion of the field

galaxies here can be put at $\sigma(\Delta v) \lesssim 50$ km s^{-1}. Therefore, distances that are accurate to better than ~20 percent can be obtained from the velocity-distance relation for galaxies whose velocities are as small as 200 km s^{-1}. The accuracy of the distance increases with the velocity. The local velocity field is as regular, linear, isotropic, and quiet as it can be made with the present material. The lack of measurable velocity perturbations, in spite of the observed density inhomogeneities, suggests that the gravitational potential energy is small compared with the kinetic energy of the expansion (provided that there is no high-density, uniform intergalactic medium), and hence that $q_0 < 1/2$. (auth)

4353 FORCED DIFFUSION: A MECHANISM TO CREATE DUST CLOUDS. Brand, P. W. J. L. (Edinburgh Univ. (UK)). Astrophys. Space Sci.; 33: No. 1, 231-234(Mar 1975).

Photodesorption from dust grains by an anisotropic radiation field will lead to much greater momentum transfer than that associated with radiation pressure. This can cause the segregation of dust to the centres of moderately dense interstellar clouds. (auth)

4354 STUDIES OF GALAXIES WITH PECULIAR NUCLEI. Pastoriza, M. G. (Observatorio Astronomico, Cordoba (Argentina)). Astrophys. Space Sci.; 33: No. 1, 173-188(Mar 1975).

Photometric, morphological, and spectral grounds suggest that the peculiar nuclei regions of NGC 1097, 1672, 2997, 5236, and 7552 are composed basically of a normal nucleus surrounded by several large but otherwise normal (T_e ~8000 K, N_e ~1000/cm^3) H II regions. The stellar components are also normal although in some cases (NGC 1097, 1672, 1808, and 7552) there is a larger contribution of late type stars. (auth)

4355 THE REDSHIFT-MAGNITUDE RELATION FOR GALAXIES. Nanni, D.; Vignato, A. (Rome Univ. (Italy). Istituto di Fisica). Astrophys. Space Sci.; 33: No. 1, 11-21(Mar 1975).

An analysis of the redshift–magnitude data for the 98 clusters of the list of Sandage and Hardy (1973) is repeated taking into account both the effect of richness and Bautz–Morgan classification on the absolute magnitude of the brightest members. It is found that while the relationship between M and B–M class—whatever it is—does not change the value of q_0 the M–r relation is so dependent on the model of the Universe that all the clusters cannot be used in the analysis unless that relation is established in an independent way. The analysis of richness 1 and 2 clusters support an open model of the Universe ($q_0 < 0.5$) while the uncertainties in the attribution of richness to the three most distant clusters do not permit one to discard the steady state. (auth)

4356 STUDY OF A NEUTRAL HYDROGEN FEATURE PREVIOUSLY OBSERVED BY CUGNON. Mirabel, I. F.; Poeppel, W. G. L. (Instituto Argentino de Radioastronomia, Buenos Aires); Vieira, E. R. (Rio Grande do Sul Univ., Porto Alegre (Brazil). Instituto de Fisica). Astrophys. Space Sci.; 33: No. 1, 23-41(Mar 1975).

An anomalous velocity cloud near l=349°, b=+3°, was investigated by Cugnon (1968). The authors made a new set of observations in order to obtain a more complete picture of the feature, including the region originally out of Cugnon's limit of observation. A comparison with optical and radio observations was made and several possibilities of interpretation as to the nature of the object were analyzed. (auth)

4357 VIBRATIONS OF INHOMOGENEOUS NON-ROTATING GRAVITATIONAL SYSTEMS. Severne, G.; Kuszell, A. (Brussels Univ. (Belgium). Faculte des Sciences). Astrophys. Space Sci.; 32: No. 2, 447-459(Feb 1975).

Dispersion relations are obtained and analyzed for a nonuniform, nonrotating gravitational system. A restriction to short wavelengths makes it possible to consider a linearized form of the collisionless Boltzmann equation, differing from that for homogeneous systems by the appearance of a term expressing the effect of the mean self-gravitational field upon the motion. The mean field affects the radially directed wave perturbations, with a breaking of symmetry. Inwardly and outwardly directed modes have quite different propagation characteristics, inward modes being preferentially propagated. Locally, the stability of the system is found to be enhanced due to the effect of the mean field. (auth)

4358 IS THE GALACTIC DISK WELL MIXED. Edmunds, M. G. (University Coll. of South Wales and Monmouthshire, Cardiff (UK)). Astrophys. Space Sci.; 32: No. 2, 483-491(Feb 1975).

A consideration of the mixing processes for heavy elements in the interstellar medium suggests that the Galaxy is well-mixed locally. Inhomogeneities would be insufficient to explain the observed abundance spread of old disk stars, or to allow the theory of metal enhanced star formation to account for the paucity of metal poor dwarfs in the solar neighborhood. Differential abundance effects during the formation of stars or clusters, or the existence of a radial abundance gradient may have to be invoked to explain the observations. (auth)

4359 GROWTH OF INTERSTELLAR GRAINS BY COAGULATION. Simons, S.; Williams, I. P. (Queen Mary Coll., London (UK)). Astrophys. Space Sci.; 32: No. 2, 493-498(Feb 1975).

A discussion is given of the spontaneous coagulation of interstellar grains due to their natural Brownian motion. It is shown that the predicted present day size of such grains, assuming such a mechanism being operative, is in reasonable agreement with observations for three different environments that have been considered: namely, normal interstellar gas clouds, molecular clouds, and the atmospheres of cool stars. (auth)

4360 SOME NEW RADIO SOURCES ASSOCIATED WITH THE SERSIC PECULIAR GALAXIES. Kaufmann, P.; Marques dos Santos, P.; Braz, M. A.; Borges, R. M. (Universidade Mackenzie, Sao Paulo (Brazil). Centro de Radio-Astronomia e Astrofisica). Astrophys. Space Sci.; 32: No. 2, L25-L27 (Feb 1975).

A program of search for radio emission from Sersic peculiar galaxies has been established. This search was conducted to establish the possible existence of strong radio sources whose angular sizes were small in relation to the antenna beam-width. In an initial list of twelve objects, four were identified as radio sources. (NL)

Cosmology

Refer also to abstracts 4342, 4674, 5277, 5290, and 5298.

4361 CAN QUANTUM GRAVITATIONAL FORCES STOP GRAVITATIONAL COLLAPSE. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Gen. Relativity Gravitation; 6: No. 1, 99-102(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

The gravitational potential between two neutrons, in lowest order of the gravitational coupling constant G, is considered. As was previously pointed out (O'Connell, Phys. Lett.; 32A: 402 (1970)), the quantum (including spin) contributions to the gravitational field dominate for distances smaller than the Compton wavelength of the neutron. At such distances the gravitational force between two neutrons may be repulsive. In particular, the gravitational forces which are analogous to the familiar Darwin and Fermi forces of quantum electrodynamics are capable of stopping gravitational collapse. The discussion is within the framework of Einstein's theory, but on a microscopic level. It is concluded that gravitational collapse may be halted without the necessity of extending Einstein's theory à la Cartan or otherwise. (auth)

4362 BIG BANG COSMOLOGY. Brecher, K. (California Inst. of Tech., Pasadena). pp 77-108 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The current view of orthodox big bang cosmology is reviewed and also the arguments for and against it. Both its geometrical and physical aspects are considered. (JFP)

4363 MICROPHYSICS, COSMOLOGY, AND HIGH ENERGY ASTROPHYSICS. Hoyle, F. (Inst. of Theoretical Astronomy, Cambridge, MA). pp 297-344 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The discussion of microphysics, cosmology, and high energy astrophysics includes particle motion in an electromagnetic field, conformal transformations, conformally invariant theory of gravitation, particle orbits, Friedman models with k equals 0, +-1, the history and present status of steady-state cosmology, and the nature of mass. (JFP)

4364 ELECTRODYNAMICS AND COSMOLOGY. Narlikar, J. V. (Inst. of Theoretical Astronomy, Cambridge, MA). pp 345-385 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

Lectures are given on the early development of electromagnetism and the role of electromagnetism in cosmology including the Wheeler–Feynman absorber theory, the response of the uni-

verse, quantum formulation, and Wheeler–Feynman without Wheeler–Feynman. (JFP)

4365 WEAK INTERACTIONS AND COSMOLOGY. Ne'eman, Y. (Tel Aviv Univ., Israel). pp 387-414 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on weak interactions and cosmology presented are time-reversal symmetry and the oscillating universe, thermodynamics and statistical mechanics of the CP violation, quasar counts and the lagging core model ("white hole"), hypercollapsed nuclear matter. (JFP)

4366 STRONG INTERACTIONS, GRAVITATION, AND COSMOLOGY. Salam, A. (Imperial Coll. of Science and Tech., London). pp 441-452 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

A progress report is given on work on gravitation and cosmology connections with particle physics. It is assumed that gravitational waves exist and that in the 21st century one will know that gravity is a quantum effect as are all other fields. (JFP)

4367 STATISTICAL ANALYSIS OF CATALOGS OF EXTRAGALACTIC OBJECTS. V. THREE-POINT CORRELATION FUNCTION FOR THE GALAXY DISTRIBUTION IN THE ZWICKY CATALOG. Peebles, P.J.E. (Physics Department, University of California, Berkeley); Groth, E.J. Astrophys. J. 196: No. 1, 1-11 (15 Feb 1975).

A three-point correlation function for the distribution of galaxies is defined and is estimated for the Zwicky catalog. The function varies like a simple power of angular scale. The index of the power law is close to twice the index for the two-point function, in agreement with the prediction of a gravitational instability model, or, more generally, with the assumption that the clustering satisfies a simple scaling property over the range of lengths for which we have estimates of the correlation functions. (auth)

4368 LARGE-SCALE RANDOM GRAVITATIONAL WAVES. Burke, W.L. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 196: No. 2, 329-334 (1 Mar 1975).

Light propagating in a region with large-scale random (i.e., wide-band) gravitational waves suffers frequency shifts which lead to a small-scale anisotropy and also a large-scale anisotropy. Here detailed calculations of the statistical properties of both of these effects are given. It is suggested that the presence of megaparsec-scale waves sufficient to close the universe and which would explain part of the apparent velocity dispersion in cluster galaxies could be detected by this large-scale anisotropy. (auth)

4369 ANISOTROPY AND LARGE SCALE DENSITY INHOMOGENEITY IN NONROTATING COSMOLOGIES. Liang, E. P. (Utah Univ., Salt Lake City (USA). Dept. of Physics). Phys. Lett., A; 51: No. 3, 141-143(24 Feb 1975).

Large scale nonrotating density fluctuations in homogeneous isotropic universes are shown to induce shear of order $\sigma/\theta_0 \sim \delta\rho/\rho_0$. Fluctuation of the decreasing mode, but not the increasing mode, is damped by shear viscosity even before entering the particle horizon. (auth)

4370 A MATTER-ANTIMATTER SEPARATION MECHANISM. Nelson, A. H. (University Coll. of South Wales and Monmouthshire, Cardiff (UK)); Rowlands, G. (Warwick Univ., Coventry (UK). School of Physics). Astrophys. Space Sci.; 33: No. 1, L1-L3(Mar 1975).

An important requirement for the matter–antimatter symmetric cosmologies that have recently been proposed (Alfvén, 1965, 1971; Harrison, 1968; Omnes, 1970) is a separation mechanism by which a uniform mixture of matter–antimatter plasma may evolve into separated cells of pure matter and pure antimatter. The plasma two-stream instability is proposed as a matter–antimatter separation mechanism for the Alfvén–Klein cosmology. (auth)

4371 ON THE THEORETICAL EVALUATION OF THE HUBBLE RED-SHIFT CONSTANT. Krat, V. A.; Gerlovin, I. L. (Pulkovo Observatory, Leningrad, U. S. S. R.). Astrophys. Space Sci.; 33: No. 1, L5-L8(Mar 1975).

The coefficient of the cosmological redshift (H_0) is calculated on the basis of the new theory of fundamental field (theory of the physical vacuum). Its value $H_0 = 2.01 \times 10^{-17}$ is in a satisfactory agreement with its experimental values. (auth)

4372 THE INFLUENCE OF STRONG INTERACTIONS ON THE EARLY STAGES OF THE UNIVERSE. Dehnen, H. (Konstanz Univ. (F. R. Germany). Fachbereich Physik); Hoenl, H. (Freiburg Univ. (F. R. Germany). Fakultaet fuer Physik). Astrophys. Space Sci.; 33: No. 1, 49-73(Mar 1975).

It is shown that the singularity of space–time in Einstein–Friedmann's cosmology can be avoided, if one takes into account the strong interaction of the elementary particles in the earliest stage of the Universe. Under the additional assumption that there exists a maximum temperature of particles and radiation ($T_{max} \simeq 1.9 \times 10^{12}$ K) in consequence of which the number of hadrons (nucleons) in the early Universe has been greater than today by a factor of about 10^7, the Friedmann equation is integrated numerically where the integration constant is fitted by the present values of the mass density, the Hubble-constant, and the temperature of the background radiation. The minimum radius of curvature of the Universe becomes 1.4×10^{11} km; the density in its neighbourhood remains within reasonable limits of the magnitude of the nuclear density. The early evolution of the Universe with time is discussed in detail. Concerning the idea of a universal upper limit for the temperature the considerations of Hagedorn are followed, but in contrast to the existing investigations the negative potential energy of the strong interaction is taken into account according to Yukawa's theory. (auth)

4373 ON THE EQUILIBRIUM FIGURES OF AN IDEAL ROTATING FLUID IN THE POST-NEWTONIAN APPROXIMATION OF GENERAL RELATIVITY. III. Stability of the Forms of Equilibrium. Pyragas, K. A.; Bondarenko, N. P. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki); Kryshtal, A. N. (AN Ukrainskoj SSR, Kiev. Inst. Matematiki). Astrophys. Space Sci.; 33: No. 1, 75-97(Mar 1975).

A stability criterion is given for the equilibrium form of an ideal rotating fluid in the post-Newtonian approximation. This generalizes the known Lyapunov criterion in classical dynamics. The sphere stability is also investigated and it is shown that it is stable only when $R > 22.2\ R_g$ (R is the relativistic sphere radius, R_g the Schwarzschild radius). (auth)

4374 LARMOR RADIUS AND COLLISIONAL EFFECTS ON GRAVITATIONAL INSTABILITY OF A COMPOSITE ROTATING PLASMA. Prakash, K.; Sharma, R. C. (Himachal Pradesh Univ., Simla (India)). Astrophys. Space Sci.; 33: No. 1, 3-9 (Mar 1975).

Gravitational instability of an infinitely conducting hydromagnetic composite rotating plasma is considered to include simultaneously the finite Larmor radius effects and the frictional effects with neutrals. It is found that Jeans' criterion of instability holds good in the presence of rotation, finite Larmor radius, and collisions with neutrals. The particular cases of the above effects on the waves propagated along and perpendicular to the magnetic field have been discussed. The effect of rotation is to decrease the Larmor radius by an amount depending upon the wave number of perturbation. (auth)

4375 RELATIVISTIC HIERARCHICAL COSMOLOGY. I. Derivation of a Metric and Dynamical Equations. Wesson, P. S. (Cambridge Univ. (UK). Inst. of Theoretical Astronomy). Astrophys. Space Sci.; 32: No. 2, 273-284(Feb 1975).

An account of hierarchical cosmology is given that is based on general relativity, being split up into three pieces for ease of assimilation. This paper derives a metric for a system based on the assumptions of (i) spherical symmetry about any local observer, (ii) a density distribution falling off as $\phi = \phi_0(t)r^{-2}$ from any local origin with the hierarchy delineated by step functions, (iii) the Universe was denser and more compact at some epoch in the past. These assumptions serve to derive a metric that allows of the definition of an effective scale factor $S'(t)$ for Hubble's law, but which involves a curvature (κ) and a parameter for measuring the radial coordinate (r/R_0) that both vary with epoch: $\kappa = \kappa(t)$, $R_0 = R_0(t)$. The metric reduces in a special case (κ = constant, R_0 = constant, $S'(t) = S(t)$ defined by the Friedmann equations) to that of a Robertson/Walker Universe. Spacetime in the hierarchy can be open or closed depending on the behavior of the dust. The equations of motion (or the field equations, equivalently) yield two equations analogous to the Friedmann equations, but including terms in the time-derivative of the curvature and a space-variable density of matter. Relativistic hierarchical cosmology provides a wider field of possible investigation with a view to describing the Universe than do the conventional uniform Robertson/Walker models. (auth)

4376 RELATIVISTIC THEORY OF SOUND PROPAGATION. Guichelaar, J. Amsterdam; Univ. Amsterdam (1974). 73p. Thesis.

The aim of this thesis is to develop the theory of sound propagation in gases within the framework of special relativity. Results of the relativistic theory of sound play a role in astrophysical

"big bang" theories. Just after the "big bang" temperatures are very high and large numbers of neutrinos and photons are present. These very conditions require a relativistic description. The properties of sound waves, e.g., the speed of propagation and the damping coefficient, are derived on two levels. Firstly the macroscopic level, where one starts from the covariant hydrodynamic equations for the gas. Secondly the microscopic level, where one starts from the relativistic extension of Boltzmann's kinetic equation. Both methods are applied to a single-component system as well as to a mixture of an arbitrary number of components. The results of the two methods are shown to be in agreement. For a model, specified by the particle cross-section, the results are considered in particular. (auth)

4377 MAGNETOHYDRODYNAMIC EQUILIBRIUM CONDITIONS IN THE POST-NEWTONIAN APPROXIMATION OF GENERAL RELATIVITY. Bondarenko, N. P.; Kravtsov, O. V. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). Astrophys. Space Sci.; 32: No. 2, 379-384(Feb 1975).

A set of equations, which are magnetohydrodynamic (MHD) equilibrium conditions in the post-Newtonian approximation of general relativity (PNA of GR), is obtained. The given system generalizes the previously obtained magnetohydrodynamic equilibrium conditions of classical mechanics and the hydrodynamic equilibrium conditions in the PNA of GR. (auth)

4378 RELATIVISTIC HIERARCHICAL COSMOLOGY. II. Some Classes of Model Universes. Wesson, P. S. (Cambridge Univ. (UK). Inst. of Theoretical Astronomy). Astrophys. Space Sci.; 32: No. 2, 305-314(Feb 1975).

Following the re-expression of the metric for a hierarchical cosmology the metric curvature is considered in showing that the hierarchy models are not, in general, related to the Robertson/Walker models even though the metrics can be made to appear superficially similar. The classes of models examined are quasi-Robertson/Walker models with $\Lambda = 0$, quasi-Robertson/Walker models with $\Lambda \neq 0$, constant curvature ($\kappa(t)$ = constant) models and zero-curvature ($\kappa(t) = 0$) models. The first group has $Q_0(t) \propto t^{-3}$, $S(t) \propto t^2$ in a suitable limit; the second group has solutions expressible as incomplete elliptic integrals of the first and third kind; the next group ($\kappa(t)$ = const.) includes an oscillating model with $Q_0(t) \propto [\sin(t/2T)]^{-2}$, $S(t) \propto [\sin(t/2T)]^{\frac{1}{2}}$ and a model with $\kappa(t) \propto \Lambda$ ($Q_0 \propto t^{-2}$), and a model with $\kappa(t) \propto \Lambda - \beta^{\frac{1}{2}}$ ($Q_0 \propto e^{\beta t}$, $\beta < 0$); the last group comprises three models, one having $\Lambda = 0$ ($Q_0 \propto t^{-2}$), one having $\Lambda = -\frac{1}{3}T^2$ where $2\pi T$ is the bounce period of the (oscillating) model, and an analogue of the de Sitter Universe with $Q_0(t) \propto e^{-\sqrt{3\Lambda}t}$ and $S(t) \propto e^{-\sqrt{(\Lambda/3)}t}$. (auth)

4379 RELATIVISTIC HIERARCHIAL COSMOLOGY. III. Comparison With Observational Data. Wesson, P. S. (Cambridge Univ. (UK). Inst. of Theoretical Astronomy). Astrophys. Space Sci.; 32: No. 2, 315-330(Feb 1975).

While Euclidean models with uniform matter density have a number of radio sources of flux density greater than F at frequency ν that varies as $N(>F,\nu) \propto F^{-\frac{3}{2}}$, hierarchial models with $Q = Q_0 r^{-2}$ have $N(>F,\nu) \propto F^{-\frac{1}{2}}$. Since the observed dependency is $N(>F,\nu) \propto F^{-1.8}$, severe density and/or luminosity evolution must be present in a workable hierarchical cosmology. The same argument applies to the number of sources of apparent luminosity greater than 1, N(>1) and to the number of sources within redshift distance z from the local origin. To give agreement with empirical data demands $q_0 = +1$ and large first and second derivatives with respect to time of the number source density. The adoption of $q_0 = +1$ allows one to show that a Lemaitre-type hierarchical Universe with a long coasting or waiting time can give agreement with observations of the numbers of QSO's etc. if the age of the Universe is more than 10^{13} yr. The dependence of the effective Hubble parameter on $\kappa(t)$, $\dot{\kappa}(t)$ and R leads one to suggest that a $\kappa = 0$, $\dot{\kappa} = 0$ hierarchy with $\Lambda \neq 0$ might be the simplest acceptable form of model Universe. It is pointed out that further data on source count anisotropies should allow the component levels of the hierarchy to be delineated. (auth)

4380 MACH'S PRINCIPLE AND BUNDLE OF GEOMETRIC QUANTITIES. Heller, M. (Uniwersytet Jagiellonski, Krakow (Poland). Obserwatorium Astronomiczne). Astrophys. Space Sci.; 32: No. 2, L29-L31(Feb 1975).

In the last years a number of papers were published dealing with various aspects of the so-called Mach's Principle (MP). In its classical version the MP postulates the relativity of inertia. A strong form of MP (SMP) requires that local inertial field should be entirely and uniquely determined by the global distribution of matter in space–time, and that the weak form of MP (WMP): the same as SMP without the words "entirely and uniquely". Of course, SMP → WMP, the converse is not true. It is shown that the bundle of geometric quantities $\sigma(M)$ over a space–time M is a strong anti-Machian element of M. (auth)

Planetary Phenomena

Refer also to abstract 5063.

4381 RADIATION BELTS OF JUPITER: A SECOND LOOK. Fillius, R. W.; McIlwain, C. E.; Mogro-Campero, A. (Univ. of California, San Diego, La Jolla). Science; 188: No. 4187, 465-467(2 May 1975).

The outbound leg of the Pioneer 11 Jupiter flyby explored a region farther from the equator than that traversed by Pioneer 10, and the new data require modification or augmentation of the magnetodisk model based on the Pioneer 10 flyby. The inner moons of Jupiter are sinks of energetic particles and sometimes sources. A large spike of particles was found near Io. Multiple peaks occurred in the particle fluxes near closest approach to the planet; this structure may be accounted for by a complex magnetic field configuration. The decrease in proton flux observed near minimum altitude on the Pioneer 10 flyby appears attributable to particle absorption by Amalthea. (auth)

4382 PIONEER 11 OBSERVATIONS OF ENERGETIC PARTICLES IN THE JOVIAN MAGNETOSPHERE. Van Allen, J. A.; Randall, B. A.; Baker, D. N.; Goertz, C. K.; Sentman, D. D.; Thomsen, M. F.; Flindt, H. R. (Univ. of Iowa, Iowa City). Science; 188: No. 4187, 459-462(2 May 1975).

Knowledge of the positional distributions, absolute intensities, energy spectra, and angular distributions of energetic electrons and protons in the Jovian magnetosphere has been considerably advanced by the planetary flyby of Pioneer 11 in November–December 1974 along a quite different trajectory from that of Pioneer 10 a year earlier. (i) The previously reported magnetodisc is shown to be blunted and much more extended in latitude on the sunward side than on the dawn side. (ii) Rigid corotation of the population of protons E/sub p/approximately 1 million electron volts in the magnetodisc is confirmed. (iii) Angular distributions of energetic electrons E/sub e/ greater than 21 million electron volts in the inner magnetosphere are shown to be compatible with the Kennel-Petschek whistler-mode instability. (iv) A diverse body of magnetospheric effects by the Jovian satellites if found. (v) Observations of energetic electrons in to a radial distance of 1.59 Jovian radii provide a fresh basis for the interpretation of decimetric radio noise emission. (auth)

4383 JUPITER REVISITED: FIRST RESULTS FROM THE UNIVERSITY OF CHICAGO CHARGED PARTICLE EXPERIMENT ON PIONEER 11. Simpson, J. A. (Univ. of Chicago); Hamilton, D. C.; Lentz, G. A.; McKibben, R. B.; Perkins, M.; Pyle, K. R.; Tuzzolino, A. J.; O'Gallagher, J. J. Science; 188: No. 4187, 455-459(2 May 1975).

During the December 1974 Pioneer 11 Jupiter encounter our experiment provided measurements of Jovian energetic protons and electrons both in the magnetic equatorial zone and at previously unexplored high magnetic latitudes. Many of the observations and conclusions from the Pioneer 10 encounter in 1973 were confirmed, with several important exceptions and new findings. Evidence from Pioneer 11 for protons (approximately 1 million electron volts) of Jovian origin in interplanetary space is reported. In the outer magnetosphere particle intensities at high magnetic latitudes were comparable to those observed in the equatorial zone, and 10-hour variations in particle intensities and spectra were observed at both high and low magnetic latitudes. Therefore, confinement of particles in the outer magnetosphere to a thin equatorial magnetodisc is adequate neither as a description of the particle distribution nor as a complete explanation of the 10-hour variations. Pioneer 11 data support a model in which the intensity varies with a 10-hour period in phase throughout the sunward side of the magnetosphere and is relatively independent of position within the magnetosphere. (auth)

4384 JUPITER'S MAGNETIC FIELD, MAGNETOSPHERE, AND INTERACTION WITH THE SOLAR WIND: PIONEER 11. Smith, E. J. (Jet Propulsion Lab., Pasadena, CA); Davis, L. Jr.; Jones, D. E.; Coleman, P. J. Jr.; Colburn, D. S.; Dyal, P.; Sonett, C. P. Science; 188: No. 4187, 451-455(2 May 1975).

The Pioneer 11 vector helium magnetometer provided precise, continuous measurements of the magnetic fields in interplanetary space, inside Jupiter's magnetosphere, and in the near vicinity of Jupiter. As with the Pioneer 10 data, evidence was seen of the dynamic interaction of Jupiter with the solar wind which leads to a variety of phenomena (bow shock, upstream waves, nonlinear magnetosheath impulses) and to changes in the dimension of the dayside magnetosphere by as much as a factor of 2. The magnetosphere clearly appears to be blunt, not disk-shaped, with a well-defined outer boundary. In the outer magnetosphere, the magnetic field is irregular but exhibits a persistent southward component indicative of a closed magnetosphere. The data contain the first clear evidence in the dayside magnetosphere of the current sheet, apparently associated with centrifugal forces, that was a dominant

feature of the outbound Pioneer 10 data. A modest westward spiraling of the field was again evident inbound but not outbound at higher latitudes and nearer the Sun-Jupiter direction. Measurements near periapsis, which were nearer the planet and provide better latitude and longitude coverage than Pioneer 10, have revealed a 5 percent discrepancy with the Pioneer 10 offset dipole model (D_2). A revised offset dipole (6-parameter fit) is presented as well as the results of a spherical harmonic analysis (23 parameters) consisting of an interior dipole, quadrupole, and octopole and an external dipole and quadrupole. The dipole moment and the composite field appear moderately larger than inferred from Pioneer 10. Maximum surface fields of 14 and 11 gauss in the northern and southern hemispheres are inferred. Jupiter's planetary field is found to be slightly more irregular than that of Earth. (auth)

4385 PIONEER 11 ENCOUNTER: PRELIMINARY RESULTS FROM THE AMES RESEARCH CENTER PLASMA ANALYZER EXPERIMENT. Mihalov, J. D. (National Aeronautics and Space Administration, Moffett Field, CA); Collard, H. R.; McKibbin, D. D.; Wolfe, J. H.; Intriligator, D. S. Science; 188: No. 4187, 448-451(2 May 1975).

Pioneer 11 observations of the interaction of Jupiter's magnetosphere with the distant solar wind have confirmed the earlier Pioneer 10 observations of the great size and extreme variability of the outer magnetosphere. The nature of the plasma transitions across Jupiter's bow shock and magnetopause as observed on Pioneer 10 have also been confirmed on Pioneer 11. However, the northward direction of the Pioneer 11 outbound trajectory and the distance of the final magnetopause crossing (80 Jupiter radii) now suggest that Jupiter's magnetosphere is extremely broad with a half-thickness (normal to the ecliptic plane in the noon meridian) which is comparable to or greater than the sunward distance to the nose. (auth)

4386 THE ATMOSPHERE AND IONOSPHERE OF IO. McElroy, M.B.; Yung, Y.L. (Center for Earth and Planetary Physics, Harvard University). Astrophys. J. 196: No. 1, 227-250 (15 Feb 1975).

A variety of models for Io's atmosphere, ionosphere, surface, and environment are developed and discussed in the context of recent observational data. The sodium emission detected by Brown appears to require a collisional excitation process in Io's atmosphere, and the extended sodium emission measured by Trafton *et al.* may require scattering of the planetary radiation by an extended sodium cloud. The sodium is presumably present initially in bound form on Io's surface and may be released by the sputtering mechanism suggested by Matson *et al.* The ionosphere detected by the radio occultation experiment on *Pioneer* 10 could be attributed to photoionization of atmospheric sodium if Io's atmosphere could sustain significant vertical motions, of order 1 s^{-1} directed up during the day, down at night. Vertical motions of this magnitude could be driven by condensation of atmospheric NH_3. The total density of gas at Io's surface appears to lie in the range 10^{10}-10^{12} molecules cm^{-3}. Corpuscular ionization could play an additional role for the ionosphere. In this case the satellite should exhibit an exceedingly bright, ~10 kR, airglow at Lα. The incomplete hydrogen torus observed by Judge and Carlson in the vicinity of Io requires a large supply of hydrogen from the satellite's atmosphere. The escape flux should be of order 10^{11} cm^{-2} s^{-1} and could be maintained by photolysis of atmospheric NH_3. The observed geometry of the hydrogen torus appears to require a surprisingly short lifetime, ~10^5 s, for neutral hydrogen near Io's orbit, and may indicate the presence of a large flux, ~10^9 cm^{-2} s^{-1}, of low-energy protons in Jupiter's magnetosphere. Implications of the hydrogen torus for the energy and mass balance of Jupiter's magnetosphere are discussed briefly, and observational programs are identified which might illuminate present uncertainties in our understanding of Io. (auth)

4387 VARIATIONS IN THE SOLAR WIND STAND-OFF DISTANCE AT MERCURY. Siscoe, G. (Center for Space Research, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Christopher, L. Geophys. Res. Lett. 2: No. 4, 158-160 (Apr 1975).

The intrinsic dipole model of the magnetosphere of Mercury is combined with statistics on the solar wind dynamic pressure from Explorers 33 and 35 to obtain histograms of the solar wind stand-off distance for aphelion, perihelion and median distance of Mercury from the sun. The results show that even at perihelion the stand-off distance lies above the surface the great majority of the time. On rare occasions, direct impact of the solar wind onto the surface will occur. (auth)

4388 MARTIAN MAGNETIC FIELD ACCORDING TO THE MARS-5 SATELLITE DATA. Gringauz, K. I.; Bezrukikh, V. V.; Verigin, M. I.; Remizov, A. P. (AN SSSR, Moscow. Inst. Kosmicheskikh Issledovanii). Dokl. Akad. Nauk SSSR; 218: No. 4, 791-794(1 Oct 1974). (In Russian).

Data are presented on the measurement of magnetic fields on board Mars-5. From an analysis of the data which were obtained it follows that the planet Mars has a magnetic field of its own. Under the action of the solar wind this field acquires a characteristic form. It is limited from the day side, and it is extended towards the night side. The topology of the field in external space is determined by the effect of all the internal and external field sources. (tr-INIS)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 4314.

4389 (ANARE-TN-8) RELATIONSHIP OF WIDEBAND VLF HISS TO THE AURORAL OVAL. Paine, R. L.; Bond, F. R. (Department of Supply, Melbourne (Australia)). Jan 1972. 5p. INIS.

Predictions of times of occurrence and intensity of hiss at very low frequency (VLF) expected at a location, based on its relation to the position of the auroral oval, agree with evidence reported in the literature. (auth)

4390 WESTWARD IONOSPHERIC CURRENTS OVER THE DIP EQUATOR DURING GEOMAGNETIC DISTURBANCES. Rastogi, R.G. (Physical Research Laboratory, Ahmedabad 380009, India). Geophys. Res. Lett. 2: No. 4, 142-145 (Apr 1975).

During geomagnetic disturbed periods, the *q* type of sporadic *E* layer near the dip equator is shown to disappear with maximum error of five minutes during the period when the difference of the geomagnetic *H* field between the equatorial and non-equatorial station decreases below the night level. These periods are identified with the reversal to westward direction of the electrojet currents at the base of the *E* region around 100 km level irrespective of the changes in the S_q current system which might be produced by the disturbance. (auth)

4391 SOLAR–TERRESTRIAL DISTURBANCES OF AUGUST 1972. Part XIII. HF Radio Wave Propagation Disturbances. Maeda, R.; Miyamoto, Y. (Radio Research Lab., Nakaminato, Ibaraki, Japan). Denpa Kenkyusho Kiho; 19: No. 103, 353-359 (Jul 1973). (In Japanese).

In this report are discussed briefly the propagation conditions of short waves observed at Hiraiso, Ibaraki early in August 1972. Several major sudden ionospheric disturbances and severe ionospheric storms which caused shortwave fade-outs and shortwave propagation storms, respectively, are considered. Even for the largest class of SID events, no changes were detected in the flux-magnitude relation between solar x-ray flares and shortwave fade-out. Effect of geomagnetic storm on shortwave propagation is found to be more obvious, that is, geomagnetic disturbances make propagation conditions more unstable for middle-latitude circuits (WWV) than low-latitude circuits (WWVH). (auth)

Magnetospheric Phenomena

4392 OBSERVATION OF THE POLAR CUSPS AND OF THE HIGH-LATITUDE MAGNETOPAUSE WITH THE EUROPEAN SATELLITE HEOS-2. Bavassano-Cattaneo, M. B.; Cerulli-Irelli, P.; Egidi, A. (CNR, Frascati, Italy). Nuovo Cim.; 26B: No. 1, 120-128(11 Mar 1975).

4393 BEAM-PLASMA INTERACTIONS AS A HEAT SOURCE IN THE MAGNETOSPHERE. Fontheim, E.G. (Space Physics Research Laboratory, University of Michigan, Ann Arbor, Michigan 48105). Geophys. Res. Lett. 2: No. 4, 150-153 (Apr 1975).

Strong electron precipitation fluxes are frequently accompanied by strong downward heat conduction fluxes, deduced from simultaneous high and low altitude electron temperature measurements. It is shown that the heat input due to beam-plasma interactions is of the correct order of magnitude to sustain the observed heat flux. (auth)

4394 IS THERE AN ELECTROSTATIC FIELD TANGENTIAL TO THE DAYSIDE MAGNETOPAUSE AND NEUTRAL LINE?. Heikkila, W.J. (University of Texas at Dallas, Richardson, Texas 75080). Geophys. Res. Lett. 2: No. 4, 154-157 (Apr 1975).

The question of possible energy dissipation that might be associated with the dayside magnetopause current requires consideration of the tangential component of the electric field. If the total current of 9×10^6 amperes flowed through the average magnetospheric dawn-dusk potential difference of 6×10^4 volts the power dissipation would be 5×10^{11} watts. We might expect this energy to be carried away by energized particles, perhaps as increased thermal or flow energy at or near the magnetopause boundary layer or mantle. Satellite observations are available, but they do not provide evidence of such energization. This failure leads us to conclude that the magnetopause current does not flow through the magnetospheric potential difference, and that the magnetopause is approximately an equipotential surface. Because of the necessary continuity of the tangential component of the electric field, this conclusion implies that there is no steady state electric field along the neutral or X-line that must be located near the dayside magnetopause in an open magnetospheric model (which is clearly supported by other evidence). Such an electric field is an essential part of the theory of merging or reconnection of magnetic field lines, and it is therefore concluded that the merging model for the electric field is not correct. This conclusion could be avoided if some evidence for the implied energy dissipation were found. (auth)

4395 WHISTLER SIDEBAND INSTABILITY. Denavit, J. (Department of Mechanical Engineering and Astronautical Sciences, Northwestern University, Evanston, Illinois 60201); Sudan, R.N. Phys. Fluids 18: No. 5, 575-584 (May 1975).

Resonant electrons in a large-amplitude whistler wave acquire a correlation in phase of their perpendicular velocities with respect to the wave magnetic field, which results in unstable growth of other whistler waves with frequencies near the main wave frequency. This instability is analyzed and the results of the analysis are compared with computer simulations. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstracts 4040, 4148, 4172, and 4481.

4396 (CEA-CONF-2880) SLOW ELECTRON SPECTROSCOPY on Mo (100). Ballu, Y.; Lecante, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Atomique). 12 Oct 1973. 13p. (CONF-740353-3). Dep. NTIS (US Sales Only) $4.00.

From 6th international vacuum congress; Kyoto, Japan (25 Mar 1974).

Backscattered electron energy distributions were measured using a high resolution cylindrical electron spectrometer. Characteristic energy losses were observed for a clean Mo (100) surface, and for the same surface covered by oxygen. The surface plasmon loss peak was identified by its position and intensity dependence on oxygen adsorption, and using optical data. Interband transitions were also observed, which may be classified in three categories: (1) Bulk transitions of Mo in agreement with optical data. (2) Transitions very sensitive to the surface state, they disappeared with adsorption of small quantities of hydrogen and oxygen. Their energy and sensitivity suggest their identification as surface state transitions. (3) New transitions due to the adsorbed molecules. (auth)

4397 (CEA-CONF-2882) THEORY OF COLLISION BETWEEN AN ATOM AND A SIMPLE CUBIC HARMONIC LATTICE. Comparison with Some Recent Experimental Results. Armand, G.; Lapujoulade, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Service de Physique Atomique). 6 Jun 1974. 13p. (CONF-740743-2). Dep. NTIS (US Sales Only) $4.00.

From 9th international symposium on rarefied gas dynamics; Gottingen, F. R. Germany (15 Jul 1974).

A theoretical calculation of neutral atom collision on a simple cubic lattice was recently achieved, taking into account the lattice temperature. All the interaction between atoms are of harmonic type. The lobe of reflection is computed assuming conservation of incident tangential momentum. The aim is to compare calculated and experimental results. In the case of helium and neon beams colliding on silver (111), with different lattice temperature, incident angle and incident particle energy, one obtains a good agreement as far as the inelastic part of the lobe is concerned. The elastic part of the lobe is not theoretically obtained with an helium beam of very low incident kinetic energy. So the theory suggests the existence of a localized surface mode due to the helium or neon-lattice interaction, the frequency of which is respectively of the order of 3 and 1.6 times the maximum frequency of the bulk. (auth)

4398 (EUR-5234d) LOW ENERGY ION-BEAM SPUTTERING AS A GENERALLY APPLICABLE SECTIONING TECHNIQUE IN MEASURING SOLID STATE DIFFUSION. Maier, K.; Schuele, W. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 22p. (In German). Dep. NTIS (US Sales Only) $4.25. EUR-BF-40,-.

Sputtering equipment for the determination of extremely small diffusion coefficients in metallic materials and semiconductors is described. It is found possible to sputter atom layers from a few Ångströms up to a few thousand Ångströms over an area of about one square centimeter. Diffusion coefficients as small as 10^{-18} cm^2/sec are determined for copper with a precision of a few percent. The values obtained for this material in the higher temperature region (700°C) fit precisely to the values obtained by mechanical methods in the same temperature region. (auth)

4399 (JINR-P7-8310) SEQUENTIAL-IMPACT IONIZATION OF POSITIVE IONS OF CARBON AND NITROGEN ($C^{2+} \rightarrow C^{3+} \rightarrow C^{4+} \rightarrow C^{5+} \rightarrow C^{6+}$ and $N^{3+} \rightarrow N^{4+} \rightarrow N^{5+} \rightarrow N^{6+} \rightarrow N^{7+}$). Donets, E. D.; Ilyushchenko, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 41p. (In Russian). Dep. NTIS (US Sales Only) $5.25.

The multicharged ion source CRION is a cryogenic version of the electron beam ion source. Positive ions are trapped by electron beam space-charge fields resulting in electron-ion collision sequences. With electric potential barriers to prevent ion escape along the axis of the electron beam during an ionization process, high electron current density up to 30 A · cm^{-2} and ionizing electron energy E_e in excess of 2 keV, the trapping time can be regulated up to 40 msec. A simple model of sequential-impact ionization process was developed. The ionization cross sections of carbon-ion sequence $C^{2+} \rightarrow C^{3+} \rightarrow C^{4+} \rightarrow C^{5+} \rightarrow C^{6+}$($E_e$ = 2500 eV) and of nitrogen-ion one $N^{3+} \rightarrow N^{4+} \rightarrow N^{5+} \rightarrow N^{6+} \rightarrow N^{7+}$($E_e$ = 2100 eV) were measured and compared with those given by the LOTZ semiempirical formula and quantum mechanical expressions. The experimental cross sections are as follows: carbon—$\sigma_{2\rightarrow3}$ = 200, $\sigma_{3\rightarrow4}$ = 57, $\sigma_{4\rightarrow5}$ = 30, $\sigma_{5\rightarrow6}$ = 14; nitrogen—$\sigma_{3\rightarrow4}$ = 125, $\sigma_{4\rightarrow5}$ = 39, $\sigma_{5\rightarrow6}$ = 9, $\sigma_{6\rightarrow7}$ = 4 (in units of 10^{-20}cm^2). Possible sources of the errors are discussed. (auth)

4400 ELECTRON BEAM GENERATOR. Khotina, A. V.; Kopnev, L. N.; Prudkovsky, G. P.; Sushkin, N. G.; Merzlikin, S. F. British Patent 1,364,531/B/. 21 Aug 1974. Filed Date 7 Sep 1971. 6p.

In the generator described the anode and cathode are arranged so that the electrons tend to follow a curved path from the cathode towards the anode, and a magnetic system is provided for producing magnetic lines of force intersecting and coplanar with the bending plane of the curved path. This results in an increase of the curvature of the beam, so that the curved path of the electrons passes by and radially outwards of the anode. The magnetic system is arranged to produce lines of force co-planar with a plane passing through both anode and cathode, the arrangement being such that the electrons are accelerated towards and pass by the anode, moving in the said plane along a curved path first across the lines of force of the magnetic field, and then, at the end of acceleration, along a particular line of force which changes direction by about 90° between the cathode and the point where acceleration is completed, so that the curved path of the electrons passes radially outwards of the anode. An additional electrode is located so as to face the electron emission direction, spaced further from the cathode than from the anode, so as to allow adjustment of the relationship between the electric and magnetic forces acting on the electrons, and the trapping of ions when this electrode is biased negatively with respect to the anode. Full details are given of the method of construction. (UK)

4401 QUANTUM-MECHANICAL MODULATION OF ELECTRONS AT PHOTOEMISSION. Hora, H. (Australian National Univ., Canberra). Nuovo Cim.; 26B: No. 1, 295-308(11 Mar 1975).

The quantum-mechanical modulation of an electron beam crossing a laser-irradiated solid has been observed and discussed extensively, and similar modulation has been concluded for electron beams crossing solids generating discrete energy losses by plasmons. Starting from an analysis of the coherence conditions for electron beams, the state of the quantum modulation is defined as a special property of a coherent beam after some inelastic scattering of the electrons in solids by photons or plasmons. From this results the quantum modulation of the electrons emitted from a photocathode by a totally reflected laser beam is discussed, if a volume photoeffect is considered, if at least a part of the photoelectrons have not been scattered inelastically during their transport process within the cathode, and if an anti-Stokes scattering of photoelectrons by the laser photons takes place analogously to the observed modulation effect. The very high monochromaticity of the laser radiation will result in electron beams of very long modulation lengths. Preliminary experiments of Farkas seem to agree with these results. (auth)

4402 LOW ENERGY ARGON DIFFERENTIAL SPUTTERING YIELDS AND THRESHOLDS ALONG THE ⟨110⟩ AND ⟨100⟩ DIRECTIONS FROM SINGLE CRYSTAL SILVER SURFACES. Tongson, L. L.; Cooper, C. B. (Delaware Univ., Newark). Radiat. Eff.; 24: No. 3, 187-193(1975).

The relative differential sputtering yields, dS, in a fixed small solid angle at various directions from a single crystal silver target under normal Ar^+ ion bombardment (ion energy from threshold to about 100 eV) were measured. The yields measured in the directions of various sputtering "spots" were: dS_1 in the 110 direction at about 60° from the (110) face; dS_2, ⟨110⟩ direction, 45° from (100) face; dS_3, ⟨110⟩ direction, 35° from (111) face; dS_4, ⟨110⟩ direction, normal to (110) face; and dS_5, ⟨100⟩ direction, normal to the (100) face. The magnitudes of the yields were: $dS_1 \tilde{>} dS_2 > dS_3$. An order of magnitude lower were $dS_4 > dS_5$. For the oblique ⟨110⟩ emissions, the curves of $(dS)^{\frac{1}{2}}$ vs incident ion energy were linear for ion energies of about 20 to 50 eV; extrapolation of these curves to zero yield gave the following sputtering threshold energies: dS_1, 14 eV; dS_2, 18 eV; and dS_3, 23 eV. (auth)

4403 HOMONUCLEAR DIATOMIC SCATTERING FROM SOLID SURFACES: A HARD-CUBE MODEL. Nichols, W.L.; Weare, J.H. (Chemistry Department, Revelle College, University of California, San Diego, La Jolla, California 92037). J. Chem. Phys. 62: No. 9, 3754-3762 (1 May 1975).

A classical mechanical hard-cube theory describing the scattering patterns of homonuclear diatomic gas beams scattered from well-defined solid surfaces is presented. The diatomic gas molecules are approximated by ellipses having rotational as well as translational energy. Scattering patterns are numerically computed with the assumption that only single collision processes are important. Analytical expressions for scattering patterns are derived by assuming that the ellipticity of a gas molecule is close to 1 and that the incident rotational energy is zero. The analytical scattering patterns exhibit the same qualitative features as the numerically computed patterns, though they do not agree quantitatively with them. The theory is briefly compared with previously presented hard-cube models. (auth)

4404 INTENSE POLARIZED ELECTRON BEAMS FROM CHEMI-IONIZATION REACTIONS WITH OPTICALLY PUMPED He($2\,^3S$). Keliher, P.J.; Gleason, R.E.; Walters, G.K. (Department of Physics, Rice University, Houston, Texas 77001). Phys. Rev. A 11: No. 4, 1279-1285 (Apr 1975).

An optically pumped flowing helium afterglow is evaluated as a potential source of polarized electrons. Spin angular momentum conservation in chemi-ionization reactions involving optically oriented He($2\,^3S$) atoms has been exploited to yield microampere electron beams with 30% polarization and energy spread ≤ 0.5 eV. The beam emittance is on the order of 10 mrad cm at 500 V extraction potential. This source appears well-suited for most spin-dependent scattering experiments that have been proposed. (auth)

4405 INTENSE ATOMIC-HYDROGEN BEAM SOURCE. Koschmieder, H.; Raible, V. (Department of Physics, University of Stirling, Stirling, Scotland). Rev. Sci. Instrum. 46: No. 5, 536-537 (May 1975).

A new design for a hydrogen atom beam source is described. A long tube is used as the source and is heated by radiation from a heater loop. Dissociation fractions of more than 80% are achieved at oven temperatures of 2500 K, with beam number densities exceeding 10^{10} atoms/cm^3. (auth)

4406 "HOT," METASTABLE ATOM, MOLECULAR BEAM SOURCE. Leasure, E.L.; Mueller, C.R.; Ridley, T.Y. (Chemistry Department, Purdue University, Lafayette, Indiana 47907). Rev. Sci. Instrum. 46: No. 5, 635-637 (May 1975).

A molecular beam source for high-energy metastable atoms, utilizing a corona discharge, is described. It was designed for scattering experiments where accurate alignment of beam components is required. The metastable atoms produced in this source have kinetic energies from 5 to 74 eV dependent on the species and sufficient velocity selection to reveal structure in the differential cross sections. These high-energy metastables were previously reported as photons. When the molecular beam source was operated at 200–300 Torr, a supersonic beam of metastables was produced. An optimization of operating conditions produced a supersonic beam flux two orders of magnitude greater than previously reported. (auth)

4407 HEAVY-ION SPUTTERING YIELD OF SILICON. Andersen, H.H.; Bay, H.L. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark). J. Appl. Phys. 46: No. 5, 1919-1921 (May 1975).

The sputtering yield for 45-keV Ar^+ irradiation of amorphous silicon is found to be in very good agreement with theory. In connection with earlier reported yields measured relative to those of argon, we here report absolute yields for 16 different ions ($7 \leq Z_1 \leq 83$). In no case does the difference between theory and experiment amount to more than 15%. The energy dependence of lead sputtering yield on silicon (25 keV $\leq E \leq$ 500 keV) is also reported and found to agree with theory. (auth)

4408 VELOCITY DISTRIBUTION AND ANGULAR DISTRIBUTION OF MOLECULAR BEAMS FROM MULTICHANNEL ARRAYS. Beijerinck, H.C.W.; Verster, N.F. (Physics Department, Eindhoven University of Technology, Eindhoven, The Netherlands). J. Appl. Phys. 46: No. 5, 2083-2091 (May 1975).

Three stainless-steel multichannel arrays with channels of 16, 50, and 140 μm diameter have been investigated experimentally. The whole flow pattern is measured, including the angular dependence of the velocity distribution. All measurements concern the opaque mode, with $\lambda \leq L$ and $\lambda \geq \alpha$, where λ is the mean free path in the source and α and L are the radius and length of the channel, respectively. The results are compared with the predictions for free molecular flow in the same channel, as a function of the reduced source density $n^* = L/\lambda$. The peaking factor is 30% lower than predicted by the Giordmaine-Wang model. At angles θ larger than the half-width–half-maximum $\theta_{1/2}$ the angular distribution is not perturbed by the opaque conditions; for $\theta < \theta_{1/2}$ it levels off to a lower peaking factor due to operation in the opaque mode. The center-line beam shows an increasing loss of slow molecules for increasing n^*. At $n^* = 10$ the gain in mean translational energy is 15%, much larger than predicted by the model of Olander. The deformation of the velocity distribution decreases with increasing angle, and for $\theta > \theta_{1/2}$ the molecules again have an unperturbed Maxwell-Boltzmann distribution. (auth)

4409 PULSED ION BEAMS FROM A HIGH-CURRENT PLASMA DIODE. Tskhadaya, B.A.; Plyutto, A.A.; Suladze, K.V. Sov. Phys.—Tech. Phys. 19: No. 8, 1108-1109 (Feb 1975).

In a study of pulsed ion beams in a high-current plasma diode it has been found that an ion beam of $6 \cdot 10^2$ A is produced when a critical diode current is reached and a discontinuity appears in the plasma. The ion beam has a large energy spread, but the average energy is approximately equal to the initial voltage, $U_0 = 30$–50 kV. The linear functional dependence of the ion-beam current on the critical diode current implies that ion beams with currents of $2 \cdot 10^4$ A can be achieved at diode currents of 10^6 A. (auth)

4410 BACKSCATTERING OF THE 10 TO 100 keV ELECTRONS FROM THICK TARGETS. Darlington, E. H. (Cambridge Univ., Eng.). J. Phys., D (London); 8: No. 1, 85-93(11 Jan 1975).

Experimental measurements of backscattering as a function of incident electron beam energy, angle of beam incidence, and atomic number of scatterer, together with energy spectra of backscattered electrons, are discussed within the framework of a simple, qualitative theory. A semi-empirical expression for the variation of backscattering coefficient with angle of beam incidence is derived. Spectra integrated over energy and angle of take off are also tabulated from experimental measurements for several elements. The use of the experimental data to derive backscattering corrections for x-ray elemental analysis, particularly at nonnormal incidence, is briefly described. (auth)

4411 EVOLUTION OF WELL-DEFINED SURFACE CONTOUR SUBMITTED TO ION BOMBARDMENT: COMPUTER SIMULATION AND EXPERIMENTAL INVESTIGATION. Docommun, J. P.; Cantagrel, M.; Moulin, M. (Domaine de Corbeville, Orsay, France). J. Mater. Sci.; 10: No. 1, 52-62(Jan 1975).

The previously published (Ducommun et al., J. Mater. Sci.; 9:725(1974)) theory of the model on the evolution of a surface contour under ion etching is recalled. Further improvement dealing with angular points of the profile shows that: angular points having straight trajectory may exist; and they can be found either by computation or by graphic method. The experimental verification of the model is made on steps etched in silicon. SEM observations of the evolution of such steps under argon ion bombardment show good agreement between computed and experimental results. (auth)

4412 THE INVERTED SPUTTER SOURCE. Chapman, K. R. (Florida State Univ., Tallahassee (USA). Dept. of Physics). Nucl. Instrum. Methods; 124: No. 1, 299-300(15 Feb 1975).

A sputter source in which the beam is extracted through the cesium ionizer works well and yields a bright beam of excellent emittance. (auth)

4413 MULTIPLY CHARGED ION SOURCE. Arianer, J.; Baron, E.; Brient, M.; Cabrespine, A.; Liebe, A.; Serafini, A.; Ton That, T. (Paris-11 Univ., 91 - Orsay (France Inst. de Physique Nucleaire). Nucl. Instrum. Methods; 124: No. 1, 157-160(15 Feb 1975).

An electron beam ion source (EBIS) has been built in the laboratory. The characteristics and performances of this kind of ion source are given. A^{14+}, Kr^{17+}, Xe^{21+} have been detected. Step-by-step collisions seem to be the main ionization phenomena. (auth)

4414 QUANTUM THEORY OF ATOM–SURFACE SCATTERING: DIFFRACTION AND RAINBOW. Garibaldi, U.; Levi, A. C.; Spadacini, R.; Tommei, G. E. (Genoa Univ. (Italy). Istituto di Scienze Fisiche). Surface Sci.; 48: No. 2, 649-675(1975).

A quantum theory of elastic scattering of atoms from crystal surfaces is presented, based on a hard corrugated surface model. It is shown in detail how the rainbow effect arises and determines the diffraction probabilities, such a rainbow effect being the quantum analog of McClure's classical rainbow. Further topics considered are the influence of a potential well and the reasons why diffraction hardly occurs from metal surfaces. The basis for a possible extension to inelastic scattering is sketched. (auth)

4415 THE SHAPE OF DOPPLER-BROADENED SPECTRAL LINES PRODUCED BY LIGHT ATOM REFLECTION FROM METALS. I. Theory. Olander, D. R.; Kerkdijk, C. B.; Smits, C. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). Surface Sci.; 49: No. 1, 28-44(Apr 1975).

A model for predicting the shapes of Doppler-broadened spectral lines due to de-excitation by photon emission of excited neutral atoms backscattered from solids is presented. The distribution of backscattered particles is calculated on the basis of single Rutherford collisions within the solid accompanied by energy loss due to electronic stopping during passage of the particle through the solid. The effect of the energy dependence

of the stopping power, radiationless de-excitation of the escaping neutral atom and the probability of the particle's leaving the surface in the desired excited state are incorporated into the calculation. The broadening of the spectral line is determined by combining the Doppler shift formula with the energy and angular distribution of the back-scattered particles. (auth)

4416 DOUBLE SCATTERING OF IONS FROM POLYCRYSTALLINE MATERIALS. Sharma, S. P. (Bell Telephone Laboratories, Incorporated, Columbus, Ohio 43213, USA). Surface Sci.; 49: No. 1, 106-124(Apr 1975).

In this paper double scattering of ions from polycrystalline materials has been theoretically investigated. It is shown that double collision events contribute to the yield at low energy as well as to the high energy flanks of the peaks depending on whether or not the azimuthal angle ϕ_1 is greater than or less than a critical angle ϕ_{1c} at a given first scattering angle θ_1. There are various combinations of first scattering angle θ_1 and second scattering angle θ_2 which give the required retained energy in two successive collisions. Scattering cross sections derived from the Bohr potential and a double interpolation subroutine are used to calculate the scattering yield at various angles. Two systems, Ne^+ scattered from copper and Ar^+ scattered from gold, each at 30 keV primary energy, have been compared with experimental results. (auth)

4417 THE SHAPE OF DOPPLER-BROADENED SPECTRAL LINES PRODUCED BY LIGHT ATOM REFLECTION FROM METALS. II. Experimental — Protons on Copper. Kerkdijk, C. B.; Smits, C. M.; Olander, D. R.; Saris, F. W. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). Surface Sci.; 49: No. 1, 45-60(Apr 1975).

During proton bombardment of a copper single crystal the Balmer-β spectral line is observed. This line, at 4861 A, is considerably broadened; the lineshape has been studied as function of impact energy (10–40 keV) and angle of incidence of the protons with respect to the surface normal. The broadening is attributed to the Doppler effect. Only fast hydrogen atoms can escape from the solid surface in an excited state. The slow moving particles undergo a resonance non-radiative decay process. This is concluded from a comparison between experimental line shapes and calculated lineshapes according to the theory of part I of this two-part paper. Good agreement with the experimental data is obtained when using for the strength of the radiationless de-excitation $A = 1.5 \times 10^8$ cm/sec. This value appears also to be consistent with the minimum yield in the proton intensity observed under channeling conditions. (auth)

4418 ENERGY DEPENDENCE OF THE BREMSSTRAHLUNG CROSS SECTION AT THE SHORT WAVELENGTH LIMIT. Aehlig, A.; Scheer, M.; Zilker, F. (Wuerzburg Univ. (F. R. Germany). Physikalisches Inst.). Phys. Lett., A; 51: No. 4, 221-222(10 Mar 1975).

The bremsstrahlung cross section has been measured at the short wavelength limit for copper. The incident energy of the electrons ranged between 100 keV and 250 keV. The Elwert-Haug calculations are found to be valid within 20%. (auth)

Atomic and Molecular Properties

Refer also to abstracts 3222, 4136, 4444, 4469, 4470, 4472, 4495, 4499, 4501, 4525, 5231, and 5267.

4419 (COO-2326-6) SELECTED BIBLIOGRAPHY ON GROUND AND EXCITED STATE POTENTIAL CURVES OF H_2, LiH, AND Li_2. Stwalley, W. C.; Zemke, W. T. (Iowa Univ., Iowa City (USA). Dept. of Chemistry; Wartburg Coll., Waverley, Iowa (USA). Dept. of Chemistry). 26 Jul 1974. Contract AT(11-1)-2326. 9p. Dep. NTIS $4.00.

A bibliography on ground and excited state potential curves of molecular hydrogen, lithium hydride, and lithium is presented. Also included is a summary of information on potentials. (JFP)

4420 (JINR-E1-8452) POSSIBILITY OF THE $X^0(958)$ MESON SPIN DETERMINATION IN THE REACTION $\pi^- p \to X^0 n$, $X^0 \to \gamma\gamma$. Lednicky, R.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

It is shown that the $X^0(958)$ spin problem can be unambiguously solved by studying the Adair distribution in the reaction $\pi^- p \to X^0 n$ in a wide angular range including very asymmetric $X^0 \to 2\gamma$ decays. It then follows that for the detector with an opening angle of ~20° the beam momentum should be about 30 GeV/c. If the beam intensity is 10^8 π^- per cycle, the accelerator time needed is expected to be about 10 days. (auth)

4421 X-RAY PHOTOELECTRON SPECTRA OF URANIUM AND URANIUM OXIDES. Correlation with the Half-Life of $^{235}U^m$. Verbist, J.; Riga, J.; Pireaux, J. J.; Caudano, R. (Facultes Universitaires, Brussels). pp 193-205 of Electron Spectroscopy: Progress in Research and Applications. Caudano, R. (ed.). Amsterdam; Elsevier Scientific Publishing Co. (1974).

From international conference on progress in research and applications of electron spectroscopy; Namur, Belgium (16 Apr 1974). See CONF-740429-.

Uranium metal and the uranium oxides UO_2, U_3O_8, UO_3 are studied by photoelectron spectroscopy. Chemical shifts of the 4f electronic core levels are measured, and the valence bands recorded. These data are correlated with measurements of the half-life of ^{235m}U for the E3 isomeric transition by electron conversion. An attempt is made to explain the electronic structure in the valence region. (auth)

4422 EXCHANGE EFFECTS IN IONIZATION OF HYDROGENIC IONS BY ELECTRON IMPACT. Banks, D. (Stirling Univ., Eng.). J. Phys., B (London); 8: No. 4, 588-602(11 Mar 1975).

The symmetric electron-exchange binary-encounter theory of Burgess and Percival (Advances in Atom. and Mol. Physics. Vol 4. pp 109-41(1968)), and Vriens (Case studies in Atomic Collisions. Chap. 6 (1969)) is extended to include an accurate account of the interference contributions, hitherto only treated approximately. The direct, exchange, interference and interference-bound terms are all derived from the Mott scattering formula for identical electrons with isotropic spin orientations. In contrast to the remaining terms, which agree with the formulae of Vriens, the interference contributions must be evaluated numerically. Accurate values of the interference contributions are presented and compared with simple analytic approximations. The present model is exact for the interaction of an intense mono-energetic electron beam with a low density isotropic gas of free mono-energetic electrons. The theory is applied to the process of ionization of highly ionized and excited hydrogenic ions by electron impact. Allowance is made for acceleration and focusing of the incident electron beam by the target nucleus. The present model should be most reliable when the nuclear charge Ze and the initial principal quantum number n are both large. The interference contributions are found to depend only upon the ratio Z/n and not upon Z and n separately. The model may be extended to nonhydrogenic target ions. (auth)

4423 INFRARED ABSORPTION SPECTRA OF GASEOUS HD. I. COLLISION-INDUCED FUNDAMENTAL BAND OF HD IN THE PURE GAS AND HD–He MIXTURES AT ROOM TEMPERATURE. Prasad, R.D.G.; Reddy, S.P. (Department of Physics, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1C 5S7). J. Chem. Phys. 62: No. 9, 3582-3589 (1 May 1975).

The infrared absorption spectra of the fundamental band of HD in the pure gas for densities up to 50 amagat and in HD–He mixtures for different base densities of HD and a number of total gas densities up to 190 amagat have been studied at room temperature. The collision-induced features of the band in the pure gas and in HD–He mixtures are similar to those previously observed for the spectra of H_2 and D_2 in the pure gases and in their binary mixtures with helium, respectively. In addition, the absorption profiles of the pure gas show the allowed sharp $R_1(1)$ transition due to the individual HD molecules. The binary absorption coefficients of the band derived from the measured integrated intensities are 2.32×10^{-35} and 0.94×10^{-35} cm^6 s^{-1} for pure HD and HD–He, respectively. An analysis of the profiles of the enhancement of absorption of the band in HD–He has been performed by assuming appropriate line shapes, and the three half-width parameters, δ_d and δ_c of the overlap transitions and δ_q of the quadrupolar transitions, are obtained. The half-width δ_c of the intercollisional interference dip of the Q branch increases with density ρ of helium and fits to the equation $\delta_c = a\rho - b\rho^2 (a > b)$. This observation and the conclusions derived from it are similar to those obtained previously for H_2–He. (auth)

4424 MOLECULAR BEAM MEASUREMENTS OF THE D–H_2 POTENTIAL AND RECALIBRATION OF THE REACTIVE CROSS SECTION. Gengenbach, R.; Hahn, C.; Toennies, J.P. (Physikalisches Institut der Universität Bonn and Max-Planck-Institut für Strömungsforschung, Göttingen, Deutsche Bundesrepublik). J. Chem. Phys. 62: No. 9, 3620-3630 (1 May 1975).

Absolute integral cross sections have been measured for D–H_2 at primary particle velocities v=7730 m/s and 9580 m/s with a 77 °K target. The number density of target particles was determined with an absolute accuracy of 1% by the method of dynamic expansion. The over-all error in the absolute cross sections is estimated to be about 1.5%. All available measurements of integral cross sections as a function of velocity were used to test literature potentials in a χ^2 procedure. A new Born–Mayer–Spline–Van der Waals (BMSV) potential is proposed that is in reasonable agreement with recent *ab initio* calculations. The potential is also consistent with the differential total cross section

measurement of Geddes, Krause, and Fite. This justifies the use of the new potential together with the differential measurements to perform an absolute calibration of the cross section for the $D + H_2 \rightarrow HD + H$ reaction. The calibrated reactive cross section is found to be in reasonable agreement with measured bulk rate constants. (auth)

4425 IMPACT BROADENING AND SHIFT OF THE Hα LINE BY HELIUM, NEON, AND ARGON. Kielkopf, J.F. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 62: No. 9, 3784-3787 (1 May 1975).

Observations are reported of the collision broadening and shift of the hydrogen α line by helium, neon, and argon foreign gases. An analysis of the line profile from a microwave-excited discharge with allowance for Doppler broadening and fine structure yields the effect of foreign gas pressure on the spectral line shape. The classical theory of spectral line impact broadening together with an interatomic potential proposed previously for alkali–noble gas interactions correctly predicts the observed broadening and shift of the line. (auth)

4426 SOME APPLICATIONS OF EXCITED-STATE–EXCITED-STATE TRANSITION DENSITIES. Yeager, D.L.; Nascimento, M.A.C.; McKoy, V. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). Phys. Rev. A 11: No. 4, 1168-1174 (Apr 1975).

We derive an approximation for transition moments between excited states consistent with the approximations and assumptions normally used to obtain transition moments between the ground and excited states in the random-phase approximation and its higher-order approximations. We apply the result to the calculation of the photoionization cross sections of the $2\,^3S$ and $2\,^1S$ metastable states of helium by a numerical analytical continuation of the frequency-dependent polarizability. The procedure completely avoids the need for continuum basis functions. The cross sections agree well with the results of other calculations. We also predict an accurate two-photon decay rate for the $2\,^1S$ metastable state of helium. The entire procedure is immediately applicable to several problems involving photoionization of metastable states of molecules. (auth)

4427 (*e*, 2*e*) PROBE FOR HYDROGEN-MOLECULE WAVE FUNCTIONS. Dey, S.; McCarthy, I.E.; Teubner, P.J.O.; Weigold, E. (School of Physical Sciences, Flinders University of South Australia, Bedford Park, South Australia 5042, Australia). Phys. Rev. Lett. 34: No. 13, 782-785 (31 Mar 1975).

The (*e*, 2*e*) reaction promises to be an extremely sensitive probe for molecular wave functions. As an initial test we have applied it to the H_2 and D_2 molecules in order to investigate its sensitivity to electronic and vibrational details. A detailed configuration-interaction wave function fits the data, whereas simpler functions do not. The simple Born-Oppenheimer approximation is confirmed to the accuracy of the experiment. The probe is compared with the Compton profile as a means of investigating the electron momentum distribution in H_2. (auth)

4428 EFFECTS OF TIME ORDERING ON PLASMA-BROADENED HYDROGEN PROFILES. Roszman, L.J. (Institute for Basic Standards, National Bureau of Standards, Washington, D. C. 20234). Phys. Rev. Lett. 34: No. 13, 785-788 (31 Mar 1975).

The plasma-broadened H_α and H_β spectral-line profiles of hydrogen were calculated retaining the time ordering in the *S* matrices of the width-shift operator by diagonalizing with the O (4) group. Significant changes occur: The H_α peak is decreased 15%, the half-width is increased 25%, and the H_β relative dip is decreased 23% without significant alteration of the maximum intensity of half-width. Agreement with experiment is improved appreciably. (auth)

4429 EXACT-EXCHANGE CRYSTAL HARTREE-FOCK CALCULATIONS OF MOLECULAR AND METALLIC HYDROGEN AND THEIR TRANSITIONS. Ramaker, D.E.; Kumar, L.; Harris, F.E. (Department of Physics, University of Utah, Salt Lake City, Utah 84112). Phys. Rev. Lett. 34: No. 13, 812-814 (31 Mar 1975).

Hartree-Fock calculations using the exact-exchange operator are reported for molecular and metallic solid hydrogen. Both calculations used the same basis set and the same crystal formalism. The calculations indicate a transition to the metallic phase at a pressure of 2.1 Mbar, in agreement with recent experiments. (auth)

4430 SPECTRUM OF KLM, N, O AUGER ELECTRONS OF Sm, Z = 62. Babenkov, M. I.; Bobykin, B. V.; Zhdanov, V. S.; Petukhov, V. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2197-2200(Oct 1974). (In Russian).

The spectrum of KLM, N, and O Auger electrons of Sm was studied on the double-focusing magnetic β spectrometer. A radioactive preparation of $^{152}Eu^*$ was the source. The results of the measurement of the relative intensities of the components of the KLM, N, and O spectrum are reported. (1 figure, 1 table) (tr-auth)

4431 MOLECULAR POLARIZABILITY AND VIBRATIONAL RAMAN TENSOR ELEMENTS OF THE H_2^+ MOLECULE. Schulman, J. M.; Detrano, R. (Queens Coll., Flushing, NY). J. Chem. Phys.; 62: No. 6, 2111-2114(15 Mar 1975).

Molecular polarizability and Raman matrix elements for the bound vibrational states of H^+/sub 2/ are calculated. The increase in the magnitude of these matrix elements with vibrational quantum number and the "structure" of the contributions from the intermediate vibronic continuum functions are explored. (2 figures, 3 tables) (auth)

4432 FAR INFRARED SPECTRA OF H_2 IN LIQUID Ar AND MEMORY EFFECTS IN THE TRANSLATIONAL BANDS. Buontempo, U.; Cunsolo, S.; Dore, P. (Istituto di Fisica "G. Marconi", Università di Roma, Roma, Italy). J. Chem. Phys. 62: No. 10, 4062-4068 (15 May 1975).

The spectra of dilute solutions of normal hydrogen and pure parahydrogen in liquid argon have been measured in the spectral range 12–700 cm^{-1}. From such spectra we have obtained the rototranslational profile and the pure translational band of orthohydrogen and parahydrogen dissolved in liquid argon. The low frequency part of the spectrum measured in the solutions of parahydrogen in liquid argon is dominated by the intercollisional interference effects, which are discussed and compared with those previously observed in solutions of Ne and He in liquid Ar using a simple model for the motion of the solute in the liquid. (auth)

4433 THE PARTIAL-WAVE SELF-CONSISTENT-FIELD METHOD FOR DIATOMIC MOLECULES: COMPUTATIONAL FORMALISM AND RESULTS FOR SMALL MOLECULES. McCullough, E.A. Jr. (Department of Chemistry and Biochemistry, UMC 03, Utah State University, Logan, Utah 84322). J. Chem. Phys. 62: No. 10, 3991-3999 (15 May 1975).

A method for performing Hartree–Fock calculations on diatomic molecules using partial-wave expansions in spheroidal coordinates is presented. This method makes no use of conventional basis set techniques but, instead, relies heavily on numerical integration. The computational formalism is described, and results of partial-wave calculations are compared with results from the standard matrix method. The partial-wave method is expected to be particularly useful for those expectation values which are difficult to compute with the matrix method. Although it is limited to diatomic molecules, the partial wave method is not limited to the Hartree–Fock level of approximation. (auth)

4434 FORMATION OF NEGATIVE HELIUM IONS BY ELECTRON CAPTURE FROM GROUND-STATE HELIUM ATOMS. Baragiola, R. A.; Salvatelli, E. R. (Comision Nacional de Energia Atomica, San Carlos de Bariloche, Argentina). J. Phys., B (London); 8: No. 3, 382-387(21 Feb 1975).

Helium negative ions were produced in collisions between ground state helium atoms and vapors of magnesium and lead in the energy range 20 to 40 keV. The results suggest the existence of a doublet state of He^-. (auth)

4435 VIBRATIONAL RELAXATION OF ORTHO AND PARA-H_2 IN THE RANGE 400–50 K. Audibert, M. M.; Vilaseca, R.; Lukasik, J.; Ducuing, J. (Laboratoire d'Optique Quantique, C. N. R. S. - Ecole Polytechnique, 91120 Palaiseau, France). Chem. Phys. Lett.; 31: No. 2, 232-236(1 Mar 1975).

The vibrational relaxation of ortho–para-H_2 mixtures was studied in the interval 400–50 K. At and above 300 K the ortho and para self-relaxation rates, k_{oo} and k_{pp}, are identical within experimental error. In the low temperature range, $k_{oo} > k_{pp}$ and k_{oo} is found to vary slowly with temperature. (auth)

4436 CLASSICAL TRAJECTORY STUDY OF ROTATIONAL RELAXATION TIMES OF MOLECULAR HYDROGEN. Gelb, A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry); Alper, J. S. (Department of Chemistry, University of Massachusetts, Boston, Massachusetts, USA). Chem. Phys. Lett.; 31: No. 2, 245-247(1 Mar 1975).

The results of a classical model calculation of the rotational relaxation of pure hydrogen vapor are presented, in which the hydrogen molecules are treated as rigid rotors and rotational transitions are computed on a diatomics-in-molecules (DIM) potential surface using classical mechanics. Rotational relaxation times are calculated for five temperatures from 300–1500 K. (auth)

4437 THEORETICAL INVESTIGATION OF THE $B'^1\Sigma_u^+$ STATE OF THE HYDROGEN MOLECULE. Wolniewicz, L. (Uniwersytet Mikolaja Kopernika, Torun (Poland). Instytut Fizyki). Chem. Phys. Lett.; 31: No. 2, 248-250(1 Mar 1975).

Potential energy curve for the excited $B'^1\Sigma_u^+$ state of the hydrogen molecule was computed for internuclear distances $1.2 \leq R \leq 5.0$ au. The dissociation energies evaluated for H_2, HD and D_2 are above the experimental results by 0.9, 3.1 and 27.2 cm^{-1}, respectively. The wavefunctions obtained are employed to compute at several internuclear distances the electronic dipole transition moment for the transition to the ground state. (auth)

4438 NEW EVIDENCE FOR A POSSIBLE HIDDEN SYMMETRY IN DOUBLY EXCITED HELIUM. Sinanoglu, O. (Yale Univ., New Haven, Conn. (USA). Dept. of Chemistry); Herrick, D. R. (Bell Telephone Labs., Inc., Murray Hill, N. J. (USA)). Chem. Phys. Lett.; 31: No. 2, 373-376(1 Mar 1975).

It is shown that the lower energy region of the doubly excited, autoionizing helium spectrum below the N = 2, 3, 4 ionization thresholds can be fitted empirically by a single three-parameter function using recently derived group theoretic quantum numbers from an SO(4) Lie algebra. The accuracy of the results suggests for helium a possible hidden symmetry which may originate from a noncompact group. (auth)

4439 EFFECT OF ERROR IN THE UNPERTURBED WAVEFUNCTION ON ELECTRIC POLARIZABILITIES AND SHIELDING FACTORS OF ATOMS. Application of Double Perturbation Theory. Kaneko, S. (Tokyo Univ. (Japan). Faculty of Engineering). Chem. Phys. Lett.; 31: No. 1, 162-165(15 Feb 1975).

The polarizability and the shielding factor of the hydrogen atom are calculated by using an approximate Hamiltonian and an approximate unperturbed wave function $\phi^{0,0}$ with one parameter. The double perturbation theory is applied for the calculation. The accuracy of $\phi^{0,0}$ is changed by varying the parameter. When the error in $\phi^{0,0}$ is small, the geometric approximation is best among various approximations investigated. (auth)

4440 REVISED THEORETICAL ENERGY FOR THE $a^3\Sigma_g^+$ STATE OF H_2. Kolos, W. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)). Chem. Phys. Lett.; 31: No. 1, 43-45(15 Feb 1975).

The Born–Oppenheimer energy of H_2 in the $a^3\Sigma_g^+$ state has been improved. The new result, with estimated values of the relativistic and nonadiabatic corrections and with the previously computed adiabatic corrections, yields $T_0 = 95077.3\ cm^{-1}$, in good agreement with the recent experimental value $T_0 = 95076.4 \pm 0.5\ cm^{-1}$ of Miller and Freund. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 4452, 4508, 4966, 5196, and 5235.

4441 (COO-3075-80) MUONIUM FORMATION IN NOBLE GASES AND NOBLE GAS MIXTURES. Stambaugh, R. D.; Casperson, D. E.; Crane, T. W.; Hughes, V. W.; Kaspar, H. F.; Souder, P.; Thompson, P. A.; Orth, H.; zu Putlitz, G.; Denison, A. B. (Yale Univ., New Haven, Conn. (USA). Dept. of Physics). 1974. 4p. (CONF-740711-17). Dep. NTIS $4.00.

From 4th international conference on atomic physics; Heidelberg, F.R. Germany (22 Jul 1974).

An experiment is reported to study the behavior of positive muons stopped in He, Ne, and Xe in order to provide a more complete understanding of muonium formation in the noble gases. Free muon and muonium precession are plotted. (JFP)

4442 (JINR-E1-8504) SHIFT OF THE ELECTRONIC X-RAYS IN HEAVY MUONIC ATOMS. Arlt, R.; Engfer, R.; Fromm, W. D.; Gansorig, D.; Krogulski, T.; Ortlepp, H. G.; Polikanov, S. M.; Sabirov, B. M.; Schneuwly, H.; Schmidt, U. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 10p. Dep. NTIS (US Sales Only) $4.00.

Energy shifts of the electronic Kx-rays of heavy muonic atoms were observed. Natural metallic targets of Ta, Ir, Pb, Th and U were used. These shifts amount to a few hundreds of eV. This effect may give rise to better understanding of the muon cascade dynamics. (auth)

4443 NONRADIATIVE TRANSITIONS IN K^- MESOATOMS. Samoilov, V. M. Yadern. Fiz.; 21: No. 2, 347-354(Feb 1975). (In Russian).

A possibility of nonradiative E2 transitions in K^- mesoatoms is considered for strongly deformed nuclei, resulting in an essential decrease of yield of the x-ray quanta. An expression is obtained for the probability of such a process. Results of the theory are used to estimate the x-ray quanta in the kaon atoms Er and U are compared with the experiment. (auth)

4444 COLLISION QUENCHING OF THE METASTABLE 2S STATE OF MUONIC HYDROGEN AND THE MUONIC HELIUM ION. Mueller, R.O.; Hughes, V.W.; Rosenthal, H. (Gibbs Laboratory, Yale University, New Haven, Connecticut 06520); Wu, C.S. Phys. Rev. A 11: No. 4, 1175-1186 (Apr 1975).

We present calculations of the cross section for quenching of the metastable 2S state of muonic hydrogen ($\mu^- p$) in collisions with a hydrogen atom, at collision energies below the threshold for inelastic 2S-2P excitation. A quantum mechanical approach based on the adiabatic approximation is used with phase shifts evaluated in the WKB approximation. Below threshold, the dominant quenching process involves Stark admixture of 2S and 2P states of $\mu^- p$ during the collision, which is accompanied by a 2P-1S radiative transition also during the collision, and consequently the cross section is reduced by several orders of magnitude compared with the inelastic cross section. These results are important to considerations of the possibility of measuring the $n = 2$ fine and hyperfine structures of $\mu^- p$. We also present quenching cross section results based on this same approach for collisions of the muonic helium ion, $(\mu^-\alpha)^+$, on He, relevant to lifetime and fine-structure measurements of $(\mu^-\alpha)^+$. Our theoretical results for $(\mu^-\alpha)^+$ differ from available experimental lifetime results for $(\mu^-\alpha)^+$, We attribute the discrepancy to uncertainties in the values of the interatomic potential in the calculations. (auth)

4445 $Z^2\alpha^4$ CORRECTION TO THE TRANSITION ENERGY IN MUONIC X-RAY. Papatzacos, P. Ark. Fys. Seminar Trondheim; No. 4, 7p(1975).

An approximate calculation of the $Z^2\alpha^4$ correction to the transition energies in muonic atoms is made. The vacuum polarization tensor is expressed in momentum space and gauge invariance is explicitly used as in the Delbrück scattering calculations. Numerical results are in reasonable agreement with Chen's values. It is unlikely that the approximations used are responsible for a factor of one or two orders of magnitude with the wrong sign, as the evaluations by Wilets and Rinker imply. (JIW)

4446 ENERGY SHIFTS OF ELECTRONIC X-RAYS IN HEAVY MUONIC ATOMS. Fromm, W. D.; Gansorig, Dz.; Krogulski, T.; Ortlepp, H. G.; Polikanov, S. M.; Sabirov, B. M.; Schmidt, U. (Joint Inst. for Nuclear Research, Dubna (USSR)); Arlt, R. (Technische Univ., Dresden (German Democratic Republic)); Engfer, R. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Hochenergiephysik); Scheuwly, H. (Fribourg Univ. (Switzerland). Inst. de Physique). Phys. Lett., B; 55: No. 4, 377-379(3 Mar 1975).

Energy shifts of the electronic K x-rays of heavy muonic atoms have been observed. Natural metallic targets of Ta, Ir, Pb, Th and U were used. The shifts amount to a few hundred eV. This effect may give rise to a better understanding of muon cascade dynamics. (auth)

4447 MEASUREMENT OF THE $2P_{\frac{3}{2}} - 2S_{\frac{1}{2}}$ ENERGY DIFFERENCE IN THE $(\mu^{-4}He)^+$ MUONIC ION BY MEANS OF A TUNABLE INFRARED DYE-LASER. Bertin, A.; Carboni, G.; Placci, A.; Zavattini, E. (European Organization for Nuclear Research, Geneva (Switzerland)); Duclos, J.; Picard, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91- Gif-sur-Yvette (France)); Gastaldi, U.; Gorini, G.; Neri, G.; Pitzurra, O. Phys. Lett., B; 55: No. 4, 411-414(3 Mar 1975).

Results of an experiment to measure the $2P_{\frac{3}{2}} - 2S_{\frac{1}{2}}$ energy difference δ_1 in the muonic $(\mu^{-4}He)^+$ ion are presented; the value $\delta_1^{exp} = 1.5274 \pm 0.0009$ eV was found. Comparison with QED predictions shows that there is agreement between theory and experiment within 0.0087 eV; this limitation is mainly due to the uncertainty with which the rms charge radius of the ^4He nucleus is known. (auth)

4448 MUONIC AND PIONIC ATOMS. Lingeman, E. W. A.; Goudsmit, P. F. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). Ned. Tijdschr. Natuurk.; 41: No. 1, 4-7(11 Jan 1975). (In Dutch).

Existing research data on pions, muons and kaons are reviewed, with particular reference to absorptive characteristics exhibited by light and heavy nuclei. Production of mesonic atoms, muon and pion x-ray spectra and the theory of muonic and pionic atoms are discussed. Tables give collated energy data of $2p \rightarrow 1s$, $3d \rightarrow 2p$, $4f \rightarrow 3d$ and $5g \rightarrow 4f$ pion transitions for various isotopes of selected light and heavy elements. Further research is possible with the IKO's 500 MeV linear electron accelerator. (NL)

4449 THE INFLUENCE OF THE CHEMICAL BOND AND THE ADMIXTURE OF HYDROGEN ON THE MUONIC X-RAY CASCADES IN IODINE AND NIOBIUM. Hartmann, F. J.; Pfeiffer, H. J.; Springer, K.; Daniel, H. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Department). Z. Phys.; 271: No. 4, 353-357(Dec 1974). (In German).

Muonic X-ray spectra have been measured for NH_4I and Nb(H) (Nb with pressed-in H_2). The results are compared with earlier experimental data on I and Nb, and with cascade calculations using various initial populations. While only minor differences between the I lines of NH_4I and elementary I were observed, big differences between the cross-over lines of Nb(H) and Nb were found. In the cases of NH_4I, I, and Nb the experimental results could be well reproduced by the cascade computations. The μ distribution between N and I in the case of

NH_4I was found to be 0.57 ± 0.08, in agreement with a recent calculation. (auth)

4450 LOCAL ENERGY CALCULATIONS EMPLOYING IMPORTANCE SAMPLING: POSITRONIUM HYDRIDE WAVE-FUNCTIONS AS SEVERE TESTS OF THE METHOD. Ehrenson, S. (Brookhaven National Lab., Upton, N. Y. (USA)). Chem. Phys. Lett.; 31: No. 3, 529-534(15 Mar 1975).

Ground-state positronium hydride wavefunctions are generated by least squares solutions of the Schroedinger equation and compared with variational results. Effects on wavefunction quality of configuration space sampling and of low-lying virtual excited states are detailed. (auth)

Collision Phenomena

Refer also to abstracts 4161, 4406, 4422, 4424, and 4427.

4451 (IS-3575) CALCULATED PRESSURE-BROADENED LINEWIDTHS OF OZONE. Tejwani, G. D. T.; Yeung, E. S. (Ames Lab., Iowa (USA)). Apr 1975. Contract W-7405-eng-82. 79p. Dep. NTIS $7.00.

Self-broadened and foreign-gas (N_2 and O_2) broadened linewidths of O_3 at 300°K for a wide range of quantum numbers J and K/sub a/, for both type A and type B bands, were calculated using the Anderson-Tsao-Curnutte theory of line broadening. In the case of O_3-O_3 collisions, dipole-dipole, dipole-quadrupole, quadrupole-dipole, and quadrupole-quadrupole interactions were included. For O_3-N_2 and O_3-O_2 collisions, dipole-quadrupole and quadrupole-quadrupole interactions were taken into account. Good agreement between the available measured linewidths with the computed values for corresponding transitions was obtained on using the molecular quadrupole moments of O_3 given by Rothenberg and Schaefer III. These values were utilized for the components of quadrupole moment tensor for O_3 in the extensive calculations of linewidths reported. Air-broadened linewidths of O_3 at 200°K were also computed. (auth)

4452 (JINR-P4-8232) SLOW COLLISIONS IN THE SYSTEM OF THREE BODIES INTERACTING BY COULOMB LAW. V. Matveenko, A. V.; Ponomarev, L. I.; Faifman, M. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 37p. (In Russian). Dep. NTIS (US Sales Only) $5.00.

The two-channel scattering problem with one of the channels closed is solved for dμ + p, pμ + p, dμ + d, tμ + t elastic scattering. A comparison with the previous experimental and theoretical data is made. (auth)

4453 (JINR-P4-8634) ITERATION-SEPARABLE METHOD IN THE THEORY OF MULTICHANNEL SCATTERING. Zubarev, A. L.; Ivlieva, I. N.; Podkopaev, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An iteration-separable method of solving the equations of the Lippman-Schwinger type is suggested. Exponential convergency of the method is proved. Numerical convergency is clarified on the e^+H scattering. Application of the method to theory of multichannel scattering is formulated. The investigation was performed at the Laboratory of Theoretical Physics, JINR. (auth)

4454 (ORNL-TM-4909) DISSOCIATIVE IONIZATION OF O_2 AND N_2 BY ELECTRON IMPACT. Deleanu, L.; Stockdale, J. A. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 100p. Dep. NTIS $8.00.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A crossed molecular-pulsed electron beam apparatus used for the study of dissociative ionization of molecules by electron impact is described. The kinetic energy spectra of O^+, N^+ and N^{++} ions formed from dissociation of O_2 and N_2 by impact of threshold to 300 eV electrons measured by a time-of-flight method are presented. The ion energy spectra were obtained as a function of incident electron energy at a fixed electron beam-ion detector angle and at a fixed electron energy for electron beam-ion detector angles between 30 and 110°. Four main groups of O^+ ions were observed peaking at 0.8, 2.0, 3.0, and 5.0 eV kinetic energy. Angular distributions of all four of these groups are essentially isotropic. Four distinct groups of N^+ ions were observed in the N^+ kinetic energy spectra peaking at 1.9 eV, 2.2 to 2.5 eV, 3 to 4 eV and 6 to 7.6 eV. The angular distributions for N^+ ions of various kinetic energies were substantially isotropic. An attempt was made to measure the excitation function of N^+ from N_2 but the results were not very satisfactory. Nevertheless the excitation function data were analyzed by plotting the N^+ kinetic energy versus the value of the electron energy at which the abrupt changes in the slope of the excitation functions ("breaks") occurred. The data on kinetic energy, angular distribution and excitation function of the ionic fragments were used in an attempt to identify the molecular ion states involved in the dissociation process. The kinetic energy spectra of N^{++}/N_2 showed at least four major peaks and the total N^{++} angular distributions was isotropic. (auth)

4455 (RLO-1388-258, pp 157-158) K-SHELL IONIZATION OF CARBON BY 1 TO 18 MeV PROTONS. Burch, D.; Graham, L. Jun 1974.

In annual report, 1974.

4456 (RLO-1388-258, pp 159-161) INNER-SHELL IONIZATION OF Pb AT ZERO IMPACT PARAMETER IN Cl + Pb COLLISIONS. Burch, D.; Ingalls, W. B.; Vandenbosch, R.; Wieman, H. Jun 1974.

In annual report, 1974.

4457 (RLO-1388-258, pp 161-162) SEARCH FOR UNITED-ATOM X-RAY TRANSITIONS IN 60-MeV Cl + Pb. Burch, D.; Ingalls, W. B.; Vandenbosch, R.; Wieman, H. Jun 1974.

In annual report, 1974.

4458 (RLO-1388-258, pp 162-165) ELECTRON LOSS IN 10-MeV He^+ AND Ar. Burch, D.; Schneider, D.; Stolterfoht, N.; Wieman, H. Jun 1974.

In annual report, 1974.

4459 (RLO-1388-258, pp 165-167) MECHANISMS FOR ELECTRON PRODUCTION IN HIGH-ENERGY $O^{n+} + O_2$ COLLISIONS. Burch, D.; Risley, J. S.; Schneider, D.; Stolterfoht, N.; Wieman, H. Jun 1974.

In annual report, 1974.

4460 (RLO-1388-258, pp 167-169) HIGH-RESOLUTION AUGER SPECTRA EXCITED IN 30-MeV OXYGEN COLLISIONS. Burch, D.; Risley, J. S.; Schneider, D.; Stolterfoht, N.; Wieman, H. Jun 1974.

In annual report, 1974.

4461 (RLO-1388-258, pp 170-171) PROJECTILE CHARGE-STATE DEPENDENCE OF Ne K-SHELL IONIZATION AND FLUORESCENCE YIELD IN 50-MeV Cl^{n+} + Ne COLLISIONS. Burch, D.; Risley, J. S.; Schneider, D.; Stolterfoht, N.; Wieman, H. Jun 1974.

In annual report, 1974.

4462 (RLO-1388-258, pp 171-172) RECOIL EFFECTS ON THE IMPACT PARAMETER DEPENDENCE OF INNER-SHELL IONIZATION BY HEAVY IONS. Burch, D. Jun 1974.

In annual report, 1974.

4463 (UCCND-CSD-INF-32) RELATIVE-COORDINATE MULTIPOLE EXPANSIONS OF INTERMOLECULAR ATOM-ATOM POTENTIALS. van Rij, W. I. (Oak Ridge National Lab., Tenn. (USA)). May 1975. Contract W-7405-eng-26. 24p. Dep. NTIS $4.25.

A subroutine VNUKAP was written to calculate the relative-coordinate multipole expansions of inter-molecular atom-atom potentials of the form exp(-kappa r)/kappa r, exp(-kappa r), and $(R/r)^2$/sup nu/, where r is the atom-atom distance, and R the molecule-molecule distance. The range parameter kappa is positive and 2nu is normally a positive integer, although VNUKAP only requires that nu be positive. (auth)

4464 SEMICLASSICAL TREATMENT OF CHARGE EXCHANGE AT LOW ENERGIES: COLLINEAR $H^+ + H_2$ COLLISIONS. Lin, Y. W.; George, T. F.; Morokuma, K. (Univ. of Rochester, NY). J. Phys., B (London); 8: No. 2, 265-272(1 Feb 1975).

S-matrix elements in the classical limit and the corresponding probabilities are calculated for the collinear charge exchange reaction $H^+ + H_2 (\nu = 5.6) \rightarrow H + H_2^+ (\nu = 0)$ for center-of-mass energies ranging from 3.5 to 4.5 eV relative to $H_2^+ (\nu = 0)$. The reaction involves an electronic transition between the two lowest adiabatic singlet potential energy surfaces of the H_3^+ system, where the ground singlet surface corresponds asymptotically to $H^+ + H_2$ and the other surface to $H + H_2^+$. The two surfaces are analytically continued from their avoided intersection to an actual intersection in the complex nuclear coordinate plane. The motion of the nuclei is assumed to be classical, and an electronic transition is effected by complex valued classical trajectories switching surfaces continuously at the complex intersection. Due to this switching the classical actions, calculated along these trajectories, gain imaginary increments. The S-matrix element for a given transition between reactants and products is calculated in terms of these classical actions, where the imaginary parts of the actions contribute exponential damping to the S-matrix element. (auth)

4465 ELASTIC FIRST BORN MATRIX ELEMENTS AND SYSTEMS CONTAINING LARGE NUMBERS OF ELECTRONS. Walters, H. R. J. (Queen's Univ., Belfast). J. Phys., B (London); 8: No. 4, L54-L57(11 Mar 1975).

It is argued that the more electrons a target atom or molecule has, the higher one has to go in energy before the first Born approximation (FBA) to elastic electron scattering can be relied upon. For excitation processes, on the other hand, the FBA should be useful in roughly the same kind of energy range for a system containing a large number of electrons as for a system containing a small number of electrons, provided that the excitation processes considered are similar. Ramifications of these two results in the theory of heavy particle collisions are pointed out. Electron loss by hydrogen atoms passing through Ar is taken as an example. It is shown how the presently existing gross discrepancy between the Dmitriev and Nikolaev (Sov. Phys. JETP; 17: 447-50 (1963)) free scattering approximation to this process and the available experimental data can be corrected. Large differences between FBA calculations of heavy particle collision processes involving targets containing large numbers of electrons and experimental data are also explained and a solution proposed. (auth)

4466 ANGULAR DISTRIBUTIONS, KINETIC ENERGY DISTRIBUTIONS, AND EXCITATION FUNCTIONS OF FAST METASTABLE OXYGEN FRAGMENTS FOLLOWING ELECTRON IMPACT ON CO_2. Misakian, M. (Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park, Maryland 20742); Mumma, M.J.; Faris, J.F. J. Chem. Phys. 62: No. 9, 3442-3453 (1 May 1975).

Dissociative excitation of CO_2 by electron impact has been studied using the methods of translational spectroscopy and an angular distribution analysis. Earlier time-of-flight studies revealed two overlapping spectra, the slower of which has been attributed to metastable $CO(a\,^3\pi)$ fragments. The fast peak is the focus of the present study. Threshold energy, angular distribution, and improved time-of-flight measurements indicate that the fast peak actually consists of five overlapping features. The slowest of the five features (1) is found to consist of the metastable $O(^3S)$ produced by predissociation of a Σ_u^+ state of CO_2 into $O(^3S) + CO(a\,^3\pi)$. Oxygen Rydberg fragments originating directly from a different Σ_u^+ state are believed to make up the next fastest feature (2). Mechanisms for producing the three remaining features are discussed. (auth)

4467 VANISHING RAINBOWS NEAR ORBITING AND THE ENERGY DEPENDENCE OF RAINBOW SCATTERING: RELATION TO PROPERTIES OF THE POTENTIAL. Greene, E.F.; Hall, R.B.; Mason, E.A. (Brown University, Providence, Rhode Island 02912). J. Chem. Phys. 62: No. 9, 3554-3559 (1 May 1975).

The energy threshold behavior of elastic rainbow scattering near the transition to orbiting is derived. Analysis of the energy dependence of the rainbow angle shows that the full range from high energies down to orbiting can be fitted with two parameters. Thus measurements of the rainbow angle can give essentially only two pieces of information about the potential. For potentials of common shapes such measurements are sensitive to regions of the potential just beyond the minimum and give information about the shape of the potential in this range. However, neither a minimum nor a point of inflection in the potential is necessary for rainbow scattering. (auth)

4468 COMMENT ON THE ACCURACY OF RABITZ' EFFECTIVE POTENTIAL APPROXIMATION FOR ROTATIONAL EXCITATION BY COLLISIONS. Green, S. (Institute for Space Studies, New York, New York 10025). J. Chem. Phys. 62: No. 9, 3568-3570 (1 May 1975).

Cross sections for rotational excitation of HCN by low-energy collisions with He have been computed with the effective potential approximation of Rabitz and compared with accurate quantum close-coupling results. Elastic cross sections are found to agree to about 20%; inelastic cross sections agree in general magnitude but not in detailed values for specific quantum transitions. (auth)

4469 VELOCITY DEPENDENCE OF THE PENNING AND ASSOCIATIVE IONIZATION CROSS SECTIONS OF Ar ATOMS BY He(2 ^3S) AND He(2 ^1S) ATOMS. Pesnelle, A.; Watel, G.; Manus, C. (Service de Physique Atomique, Centre d'Etudes Nucléaires de Saclay, BP N°2-91190 Gif-sur-Yvette, France). J. Chem. Phys. 62: No. 9, 3590-3600 (1 May 1975).

The velocity dependence of both the Penning and associative ionization cross sections σ_{PI} and σ_{AI} of Ar atoms by He(2 ^3S) and He(2 ^1S) metastable atoms, and of their sum $\sigma_T = \sigma_{PI} + \sigma_{AI}$, is measured in the velocity range 1200–4500 m/sec (30–400 meV) in a crossed-beam experiment by a time-of-flight technique. Characteristic cross-section ratios σ_{AI}/σ_T and $\sigma_T(\text{singlet})/\sigma_T(\text{triplet})$ are reported along with the relative magnitude of the cross sections σ_{AI}, σ_{PI}, σ_T. The measurements clearly show a difference in the reaction mechanisms involving He(2 ^3S) and He(2 ^1S). This difference appears not only in the ratio σ_{AI}/σ_T, whose magnitude reaches 19% and 38% for He(2 ^3S) and He(2 ^1S), respectively, at the velocity $v = 1200$ m/sec (30 meV), and in the ratio $\sigma_T(\text{singlet})/\sigma_T$ (triplet), which increases from 0.5 to 3.8 for velocity decreasing from 4500 m/sec to 1200 m/sec, but also in the different shapes of the σ_{AI} and σ_{PI} cross sections for He(2 ^3S) and He(2 ^1S). The experimental results for He(2 ^3S) are also compared to theoretical calculations made in the classical impact parameter formulation. The model gives a total ionization cross section σ_T and partial ionization cross sections σ_{AI} and σ_{PI} in good agreement with the data. Information on both the coupling width and the He + Ar^+ interaction potential well are obtained. (auth)

4470 THREE-DIMENSIONAL QUANTUM MECHANICAL STUDIES OF $D + H_2 \rightarrow HD + H$ REACTIVE SCATTERING. Tang, K.T.; Choi, B.H. (Department of Physics, Pacific Lutheran University, Tacoma, Washington 98447). J. Chem. Phys. 62: No. 9, 3642-3658 (1 May 1975).

A three-dimensional quantum mechanical study is made on the reactive scattering of $D + H_2 \rightarrow DH + H$. The differential and total cross sections as well as the S-matrix elements are obtained from the adiabatic distorted wave model. With the initial molecule H_2 in the ground rotational state, we calculated the cross sections for reactions to all possible rotational states of the product molecule DH. The potential used is that of the Porter and Karplus semiempirical surface. The reactive scattering is predominantly backward. However, the peak in the differential cross sections gradually shifts away from $\theta = \pi$ as the energy is increased, with higher rotational states shifting more. In the thermal energy region, there is virtually no scattering in forward directions. The reaction is endothermic but only slightly so. Although the $0 \rightarrow 0$ rotational transition contributes only a small fraction to the total reactive cross section, most product molecules prefer rotational states that are considerably lower than the highest one allowed by energy conservation. Differential cross sections summed over all possible final rotational states are significantly different from that of any one state. Previous three-dimensional quantum mechanical studies on this system are all limited to one final rotational state; these previous results are compared with the result of the corresponding case in the present study. The present results are also compared with the corresponding classical trajectory calculations on the same potential surface. Finally, the experimental measurements of Geddes, Kraus, and Fite are compared with the present results. Qualitatively, there are general agreements, but quantitatively the calculated cross sections are definitely too large as compared with the experimental ones. The most likely cause for this difference is that the potential surface used is "too reactive." (auth)

4471 MULTIPLET GENERALIZED OSCILLATOR STRENGTHS AND INELASTIC SCATTERING CROSS SECTIONS CALCULATED INCLUDING THE ELECTRON CORRELATION EFFECTS: TRANSITIONS OF NEUTRAL ATOMS: Be, B, C, N, AND O. Davis, S.L.; Sinanoğlu, O. (Sterling Chemistry Laboratory, Yale University, New Haven, Connecticut 06520). J. Chem. Phys. 62: No. 9, 3664-3670 (1 May 1975).

The generalized oscillator strengths as a function of momentum transfer q and the integrated inelastic cross section as a function of incident electron kinetic energy E are calculated with accurate inclusion of all of the nonclosed-shell-type correlations in both initial and final states using the new atomic structure theory for excited states of Sinanoğlu for BeI $2s^2\ ^1S \rightarrow 2s2p\ ^1P^0$, BI $2s^2 2p^2\ ^2P^0 \rightarrow 2s2p^2\ ^2D$, BI $2s^2 2p^2\ ^2P^0 \rightarrow 2s2p^2\ ^2P$, CI $2s^2 2p^2\ ^3P \rightarrow 2s2p^3\ ^3D^0$, CI $2s^2 2p^2\ ^3P \rightarrow 2s2p^3\ ^3P^0$, CI $2s^2 2p^2\ ^3P \rightarrow 2s2p^3\ ^3S^0$, NI $2s^2 2p^3\ ^4S^0 \rightarrow 2s2p^4\ ^4P$, and OI $2s^2 2p^4\ ^3P \rightarrow 2s2p^5\ ^3P^0$. Some difficult variational problems in these neutral atom states, some of which are not the lowest of their symmetry, have to be and are properly dealt with here. The results show large effects of correlation as compared with Hartree–Fock calculations on both the magnitudes and the shapes of the curves. Similar effects will occur in the electron impact spectra of molecules. (auth)

4472 ELECTRON-IMPACT IONIZATION CROSS SECTIONS AND BOUND-FREE GENERALIZED OSCILLATOR STRENGTHS FOR ATOMIC SYSTEMS. Robb, W.D. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302); Rountree, S.P.; Burnett, T. Phys. Rev. A 11: No. 4, 1193-1199 (Apr 1975).

Within the Born approximation, a general formulation is given for differential cross sections corresponding to electron-impact ionization of an arbitrary L-S-coupled atomic system. Expressions for the generalized oscillator strength and total cross section are also given. Correlation effects are explicitly included in the formulation through the use of a configuration-interaction wave function to describe the initial bound target state, and a close-coupling wave function to describe the final free target state. Two independent computer codes have been constructed which allow these functions to be of arbitrary complexity for any atom. The codes use recently developed, but different, techniques for solving the close-coupling equations. Test results are obtained for the helium atom, and they agree well with previous correlated calculations. (auth)

4473 NONMETASTABLE PENNING IONIZATION IN He(3 ^1P) -Ne, Ar, Kr, Xe COLLISIONS. Kubota, S.; Davies, C.; King, T.A. (Physics Department, Schuster Laboratory, University of Manchester, Manchester M13 9PL, England). Phys. Rev. A 11: No. 4, 1200-1204 (Apr 1975).

Time-dependent spectroscopy techniques have been used to determine the cross sections for the deexcitation of nonmetastable He(3 ^1P) states

by collision with Ne, Ar, Kr, or Xe atoms. The measured cross sections in 10^{-16} cm^2 at $600_{-100}{}^{+200}$ °K are, for Ne, $27.6_{-2.8}{}^{+4.5}$; Ar, $55.6_{-7.8}{}^{+10.6}$; Kr, $49.5_{-4.8}{}^{+8.0}$; and Xe, $73.0_{-8.8}{}^{+12.9}$. These cross sections are compared with theoretical Penning ionization cross sections having values of 20 for Ne, 40 for Ar, 39 for Kr, and 35 for Xe, in units of 10^{-16} cm^2 (at 600 °K). (auth)

4474 BINDING EFFECTS IN HIGH-ENERGY SCATTERING APPLIED TO *K*-SHELL IONIZATION. Binstock, J.; Reading, J.F. (Physics Department and Cyclotron Institute, Texas A&M University, College Station, Texas 77843). Phys. Rev. A 11: No. 4, 1205-1213 (Apr 1975).

The equation describing scattering of a fast ion by a *K*-shell electron, $i\hbar v\partial S_I/\partial Z = \exp(i\vec{H}_e Z/\hbar v)V(\vec{r},\vec{R})\exp(-i\vec{H}_e Z/\hbar v)S_I$, where $H_e(r) = -(\hbar^2/2m_e)\nabla_r^2 - (\hbar^2/m_e)[\partial \ln\chi_0(r)/\partial r]\partial/\partial r \equiv FT + BT$, is solved in the Glauber approximation by setting H_e to zero and in the Cheshire approximation by setting the binding term (BT) to zero. In this paper we solve for S_I including both the freely recoiling term (FT) and BT but neglecting their commutator. A divergence found with this method in a previous investigation of hydrogenlike atoms is removed as long as $Z_S e^2/\hbar v < 1$. This limit represents a natural "threshold" in the method since for lower velocities the target electron is moving faster than the projectile. We apply the method in its lowest-order approximation to *K*-shell ionization by differently charged projectiles. A substantial improvement in the fit to the ratio r_{12} given by $r_{12} = \sigma(Z_1)Z_2{}^2/\sigma(Z_2)Z_1{}^2$, $Z_1 > Z_2$, is found in comparison with the Glauber and Cheshire results. More experiments are needed with $Z_S \lesssim 20$ and at energies such that $Z_S e^2/\hbar v < 1$ to test this new theory. The method has immediate applicability to any scattering problem in which the projectile has a classical trajectory. (auth)

4475 ELECTRON EXCITATION CROSS SECTIONS OF $N_2{}^+$ $B^2\Sigma_u{}^+$, N I, AND N II STATES AND THEIR TEMPERATURE DEPENDENCE. Lewis, J.W.L.; Price, L.L.; Powell, H.M. (von Karman Gas Dynamics Facility, Arnold Research Organization, Inc., Arnold Engineering Development Center, Arnold Air Force Station, Tennessee 37389). Phys. Rev. A 11: No. 4, 1214-1222 (Apr 1975).

The relative apparent electron-excitation cross sections $\sigma(v)/\sigma(0)$ for vibrational levels $1 \leq v \leq 4$ of the $N_2{}^+$ $B^2\Sigma_u{}^+$ state were measured over the temperature range of 300–900 K using an electron beam of 10-keV energy. Enhancement was observed for all temperatures investigated for the values of $\sigma(v)/\sigma(0)$ for $v = 2$, 3, and 4 relative to the values predicted using emission band strengths and excitation Franck-Condon factors. The values of $\sigma(1)/\sigma(0)$ agreed with calculated values to within experimental uncertainty. The apparent cross sections were determined for the N II levels $2p\,(^2P^0)3p$, $2p\,(^2P^0)3d$, and $2p\,(^2P^0)4f$ and the $2p^2(^3P)4p$ level of N I. To the accuracy of the measurement no temperature dependence of the atomic cross sections was observed. (auth)

4476 ELECTRON IMPACT EXCITATION OF Hg^+. Crandall, D.H.; Phaneuf, R.A.; Dunn, G.H. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302). Phys. Rev. A 11: No. 4, 1223-1232 (Apr 1975).

Crossed beams of electrons and Hg^+ ions have been employed to measure absolute cross sections for 165.0-nm emission, corresponding to the transition $Hg^+(6p^2P_{3/2}{}^0) \rightarrow Hg^+(6s^2S_{1/2})$. The emission cross section, which is nearly identical to the excitation cross section for $Hg^+(6p^2P_{1/2}{}^0)$ near threshold, has a value of about 1.2×10^{-16} cm^2 at the 7.51-eV threshold, rises to a maximum of 2.26×10^{-16} cm^2 at 13 eV, and falls to 0.64×10^{-16} cm^2 at 274 eV. The cross section exhibits considerable structure in the energy region from threshold to the onset of the first cascade ($7s^2S_{1/2}$) at 11.9 eV; this structure is likely due to interference from autoionizing states of neutral Hg. The total uncertainty at a "good" confidence level is about 18%, taken as the quadrature sum of random uncertainty (5% at 90% confidence level) with systematic uncertainties (17% at a level equivalent to 90% confidence level). At threshold, the Gaunt-factor formula of Seaton predicts a value of about 3 times that measured, but the two converge to within about 15% for electron energies ranging from 13 to 274 eV. The results are also in reasonable agreement with a semiclassical Gryzinski-type calculation for energies above several times threshold. The data give an emission cross section of $(2.8 \pm 0.5) \times 10^{-16}$ cm^2 at 6.8 eV for 194.2 nm ($6p^2P_{1/2}{}^0 \rightarrow 6s^2S_{1/2}$). Analysis of data taken with some metastable $6s^2\,{}^2D$ ions in the target beam indicates that the mean cross section for excitation of the $6s^2P_{3/2}{}^0$ level from the $6s^2\,{}^2D$ metastable states is larger than that for excitation from the $6s^2S_{1/2}$ ground state. Additional measurements of 398.4-nm emission ($6p^2P_{3/2}{}^0 \rightarrow 6s^2\,{}^2D_{5/2}$) yield a cross section of about 6×10^{-19} cm^2 near threshold, and a branching ratio $(^2P_{3/2} \rightarrow {}^2S_{1/2})/(^2P_{3/2} \rightarrow {}^2D_{5/2})$ of 350/1. (auth)

4477 *K*-SHELL IONIZATION CROSS SECTIONS IN ASYMMETRIC HEAVY-ION–ATOM COLLISIONS. Brandt, W.; Laubert, R. (Department of Physics, New York University, New York, New York 10003). Phys. Rev. A 11: No. 4, 1233-1238 (Apr 1975).

Experimental x-ray production cross sections for Ne projectiles impinging on thick Al foils and Ar projectiles on Si foils reveal that, in asymmetric atom-atom collisions, *K*-shell vacancies are created in both collision partners. Only in the almost adiabatic collision regime at very low velocities, corresponding to projectile energies $E_1 < 20$ keV/amu, are all of the vacancies created in the collision partner with the lower atomic number, as predicted by the electron-promotion model of Pauli excitation. At higher energies, $E_1 > 25$ keV/amu, the ratio of the *K*-shell x-ray production cross section of the heavier collision partner to that of the lighter collision partner increases approximately as the square of the incident ion energy, and can exceed unity. It provides experimental evidence for Pauli excitation of both *K* shells under nonadiabatic conditions. (auth)

4478 IONIZATION IN LOW-keV-ENERGY Ar + Ar COLLISIONS. Eriksen, F.J.; Fernandez, S.M.; Bray, A.B.; Pollack, E. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. A 11: No. 4, 1239-1244 (Apr 1975).

Ionization in Ar-Ar collisions is studied at beam energies of 2.00, 2.50, and 3.00 keV over an angular range from 2.0° to 12.0°. The ionization probability (P_1) shows a threshold for $\tau \simeq 5$ keV deg and a second rise for $\tau \simeq 25$ keV deg. The scattered ion beam is energy analyzed at selected energies and angles. For $2 < \tau < 12$ keV deg the ion energy-loss spectra show a double-peaked structure, at an 18-eV and at a 29-eV energy loss. At larger τ there is predominately one peak in the spectra at 43 eV. The energy losses and τ dependence of P_1 suggest that the 29- and 43-eV processes involve excitation of autoionizing states. Additional results at beam energies of 0.50, 0.75, 1.00, and 1.50 keV show $P_1(\tau)$ to be velocity dependent at these lower energies. (auth)

4479 COLLISIONS BETWEEN RARE-GAS ATOMS AT LOW keV ENERGIES. I. SYMMETRIC SYSTEMS. Brenot, J.C.; Dhuicq, D.; Gauyacq, J.P.; Pommier, J.; Sidis, V.; Barat, M.; Pollack, E. (Laboratoire de Collisions Atomiques, Bâtiment 220, Université Paris-Sud, 91405 Orsay, France). Phys. Rev. A 11: No. 4, 1245-1266 (Apr 1975).

Elastic and inelastic collisions in the symmetric He-He, Ne-Ne, Ar-Ar, and Kr-Kr systems are investigated experimentally and theoretically at low keV energies (0.5–4 keV). Standard techniques, employing electrostatic energy analysis for ions and time-of-flight methods for neutrals, are used in energy-loss measurements. The characteristic energy spectra of the scattered beams generally show three peaks corresponding to elastic scattering and collisions resulting in one- or two-electron excitations. Of particular significance is the dominance of the lowest-lying *p* levels in the inelastic scattering. Differential cross sections are determined at select energies, and the interpretation of the results is made in the framework of the electron-promotion model. *Ab initio* calculations are performed for the Ne and Ar cases. The primary mechanism in the inelastic scattering always involves one- or two-electron transitions from a promoted incident molecular orbital by rotational coupling for He-He, and by radial coupling in the Ne-Ne and Ar-Ar cases. Predictions based on the assumed model are compared with results of related experiments. (auth)

4480 ANISOTROPY OF CHARACTERISTIC *K*-SHELL X RAYS FROM HEAVY-ION–ATOM COLLISIONS. Pedersen, E.H.; Czuchlewski, S.J.; Brown, M.D.; Ellsworth, L.D.; Macdonald, J.R. (Physics Department, Kansas State University, Manhattan, Kansas 66506). Phys. Rev. A 11: No. 4, 1267-1270 (Apr 1975).

Angular distributions have been measured and polarization fractions, determined for target and projectile x rays emitted in collisions of 3-MeV protons on argon and 33-MeV fluorine ions on argon and helium. The near isotropy in target x-ray emisssion that follows *K*-shell ionization is not unexpected; however, the anisotropic emission of projectile x rays contradicts the assumptions that are made in the analysis of x-ray cross sections. The polarization of ≈23% in this characteristic *K*-shell radiation can be understood qualitatively from the alignment of excited states populated by electron capture in atomic collisions. (auth)

4481 SPIN CONSERVATION DURING CHEMI-IONIZATION AND SURFACE-ELECTRON EJECTION BY He($2\,{}^3S$). Keliher, P.J.; Dunning, F.B.; O'Neill, M.R.; Rundel, R.D.; Walters, G.K. (Department of Physics, Rice University, Houston, Texas 77001). Phys. Rev. A 11: No. 4, 1271-1278 (Apr 1975).

The conservation of spin angular momentum during inelastic collisions of spin-oriented metastable He($2\,{}^3S$) atoms with contaminated surfaces and a variety of gaseous targets, including Ar, H_2, N_2, CO, CO_2, and N_2O, has been investigated. The metastables are contained in a flowing helium afterglow and are oriented by optical pumping. The electrons produced during subsequent chemi-ionization and surface-ejection reactions are extracted and spin analyzed by Mott scattering. Spin angular momentum is found to be fully conserved for all the reactions studied, with the possible exception of the chemi-ionization of CO. The experimental results are discussed in the light of existing theories and models for chemi-ionization. The results also suggest that secondary electron ejection from chemically cleaned surfaces occurs through chemi-ionization of adsorbed species. (auth)

4482 MOLECULAR SCATTERING: CONVERGENCE OF CLOSE-COUPLING EXPANSIONS IN THE PRESENCE OF MANY OPEN CHANNELS. Garrett, W.R. (Health Physics Division, Oak

Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. A 11: No. 4, 1297-1302 (Apr 1975).

In low-energy atomic scattering theory it is well known that the accuracy of the familiar target eigenstate expansion or "close coupling" methods cannot be totally relied upon unless all open channels of the target system are included in the expansion. We show that the same methods, as applied to low-energy scattering by a molecular target, converge even though all open channels above a certain energy level may be truncated in the target eigenstate expansion. The result is applicable only in the energy regime where rotational channels are open but vibrationally and electronically excited state channels are closed. (auth)

4483 ELECTRON EMISSION FROM PROTON–HYDROCARBON-MOLECULE COLLISIONS AT 0.3–2.0 MeV. Wilson, W.E.; Toburen, L.H. (Battelle, Pacific Northwest Laboratories, Richland, Washington 99352). Phys. Rev. A 11: No. 4, 1303-1308 (Apr 1975).

Cross sections, differential in ejection energy and angle, for electron emission from methane, ethane, ethylene, acetylene, and benzene molecules following proton impact have been measured for protons of 0.3-, 1.0-, and 2.0-MeV energy, in an attempt to observe a variation in the electron yield attributable to the chemical form or molecular binding of the target atoms. The results indicate that emission cross sections for electrons ejected with energy greater than about 10 eV show no effects related to the molecular structure within this group of molecules. When the results are compared with similar data for molecular hydrogen however, one observes a significant difference in the angular dependence of the emission cross sections between the hydrocarbons as a group and hydrogen; the emission from the hydrocarbons is more isotropic than from hydrogen. This observation indicates that the amount of ionization produced by energetic charged particles may be different in different gaseous mixtures containing hydrogen and hydrocarbon gases. The double-differential cross sections for the group of hydrocarbons are found to be scalable in terms of the number of weakly bound electrons in the molecule. (auth)

4484 VIBRATIONAL EXCITATION IN N_2O VIA THE 2.3-eV SHAPE RESONANCE. Azria, R.; Wong, S.F.; Schulz, G.J. (Department of Engineering and Applied Science, Mason Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. A 11: No. 4, 1309-1313 (Apr 1975).

The vibrational excitation of N_2O by electrons in the energy range 1–4 eV has been studied with a crossed-beam apparatus using an energy resolution of 22 meV and an observation angle of 40°. The scattering in the middle of this energy range is dominated by the $^2\Sigma^+$ shape resonance which contributes to the excitation of about 20 vibrational modes. The vibrational modes belong to four series, namely, the $n00$, $n10$, $n01$, and $n02$ series with the quantum number n ranging from 0 to 7. The energy dependence of the differential vibrational cross sections is bell shaped and exhibits no fine structure. At the center of the $^2\Sigma^+$ resonance (2.3 eV), the $n00$ series is most intensely excited and has a cross section of $(9.6 \pm 3.5) \times 10^{-18}$ cm^2/sr for $n = 1$ and an exponentially decreasing magnitude for successively higher n. A similar trend of the branching ratio has also been observed in the $n01$ series. The present experiment combined with a calculation of Dubé and Herzenberg demonstrates that the impulse picture, which was originally proposed for the case of vibrational and rotational excitation in H_2, is applicable to this triatomic molecule as well. The width Γ for the $^2\Sigma^+$ shape resonance of N_2O has been found to be 0.7 eV in the center of the Franck-Condon region, and it decreases for larger internuclear separations. (auth)

4485 RESONANT ELECTRON-MOLECULE SCATTERING: THE IMPULSE APPROXIMATION IN N_2O. Dubé, L.; Herzenberg, A. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). Phys. Rev. A 11: No. 4, 1314-1325 (Apr 1975).

N_2O is a linear triatomic molecule. Electron scattering shows a $^2\Sigma^+$ shape resonance at ≈ 2.3 eV. The lifetime turns out to be so short, 0.9×10^{-15} sec, that one has an impulse picture, in which the nuclei acquire velocity but suffer little displacement during the residence of the projectile electron. The nuclear wave equation at the resonance is solved in the impulse approximation, and is shown to give a good account of the excitation of more than 20 vibrational states observed by Azria, Wong, and Schulz. (auth)

4486 HIGH-ENERGY BEHAVIOR OF THE VIBRATIONAL EXCITATION CROSS SECTION σ_{01} FOR H^+-H_2. Azziz, N.; Herrero, F.A. (Department of Physics, University of Puerto Rico and Puerto Rico Nuclear Center, Mayaguez, Puerto Rico 00708); Mendez-Plácido, R. Phys. Rev. A 11: No. 4, 1326-1333 (Apr 1975).

We present calculations of the cross section σ_{01} for the vibrational excitation of H_2 by proton impact with several interaction potentials. The calculation with a long-range anisotropic potential shows features very similar to the calculation with the H_3^+ potential surface, but both calculations fail to account for the observed persistence of the cross section at high velocities (proton energy range from 200 to 1000 eV). A trajectory-dependent potential is introduced semiempirically, and it is found that the main features of the observed cross section can be explained by its short-range parts ($r \lesssim 2$ Å). The significance of this potential is discussed. The approximation scheme involves first-order time-dependent perturbation theory and considers only rectilinear trajectories. Therefore, for the case reported here, the calculation is valid for energies higher than about 200 eV, where the trajectories are essentially rectilinear. The semiempirical deduction of the trajectory-dependent potential was greatly simplified by representing the time-dependent potential by a Gaussian pulse. The results are compared with a previous calculation. (auth)

4487 THEORETICAL LOW-ENERGY SCATTERING CROSS SECTIONS FOR $He(2\,^1S) + He(1\,^1S) \rightleftharpoons He(2\,^1P) + He(1\,^1S)$. Shipsey, E.J.; Browne, J.C. (Departments of Computer Sciences and Physics, University of Texas at Austin, Austin, Texas 78712); Olson, R.E. Phys. Rev. A 11: No. 4, 1334-1339 (Apr 1975).

Ab initio potential-energy calculations have been performed on the $C\,^1\Sigma_g^+$ state of $He(2\,^1S) + He(1\,^1S)$ and on the $B\,^1\Pi_g$ state of $He(2\,^1P) + He(1\,^1S)$; the L_y rotational-coupling matrix elements were also calculated. The potential curves were found to cross at $R = 3.89a_0$, where $L_y = 0.68$. Close-coupled calculations were then used to predict the cross sections for collision energies $E \leqslant 100$ eV. The excitation total cross section was found to rise rapidly from the threshold at $E = 0.60$ eV to values greater than 1×10^{-16} cm^2 at collision energies $E \gtrsim 4$ eV. The inelastic-scattering total cross section for the reverse reaction, deexcitation of $He(2\,^1P)$ by $He(1\,^1S)$, was found to be greater than 1×10^{-17} cm^2 at thermal energies and yields a Boltzmann-averaged rate of k (300 °K) $= 2.9 \times 10^{-12}$ cm^3/sec. At energies $E \lesssim 3$ eV, sharp peaks are found on the inelastic-scattering total cross sections and are attributed to quasibound states present at these low energies. The inelastic-scattering differential cross sections are forwardly peaked with most of the scattering appearing at reduced angles $\tau = E\theta \lesssim 250$ eV deg. (auth)

4488 *Ab initio* CROSS SECTIONS FOR EXCITATION OF THE 2*p* STATE OF HYDROGEN BY ELECTRON IMPACT AT INTERMEDIATE ENERGIES. Brandt, M.A.; Truhlar, D.G. (Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. A 11: No. 4, 1340-1346 (Apr 1975).

Differential and integral cross sections for the 1*s*-2*p* excitation of the hydrogen atom at impact energies of 0.81, 1.00, 1.21, 1.44, 2.25, and 4.00 Ry are calculated from the most accurate available *ab initio* calculations and tabulated. (auth)

4489 SYMMETRIC ION-ATOM COLLISIONS AT MEDIUM ENERGIES: NONCHARACTERISTIC RADIATION. Laubert, R.; Haselton, H.H.; Mowat, J.R.; Peterson, R.S.; Sellin, I.A. (University of Tennessee, Knoxville, Tennessee 37916 and Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. A 11: No. 4, 1468-1471 (Apr 1975).

We have observed the *K*-shell–associated noncharacteristic radiation emitted in Al-Al and Ni-Ni collisions in the range 0.1–0.75 MeV/nucleon and determined the production cross section. We find that most of the predictions of Lichten regarding the cross section are borne out by the experimental data. (auth)

4490 EIKONAL APPROXIMATION APPLIED TO MANY-ELECTRON ATOMS. Williamson, W. Jr.; Foster, G. (Department of Physics and Astronomy, The University of Toledo, Toledo, Ohio 43606). Phys. Rev. A 11: No. 4, 1472-1474 (Apr 1975).

The scattering of electrons by target atoms with Q electrons is considered in the full eikonal approximation. An expression for the scattering amplitude is given which reduces the number of integrations from $3Q + 3$ to $2Q$. (auth)

4491 ELECTRON IMPACT AUTOIONIZATION IN HEAVY ALKALI METALS. Nygaard, K.J. (Department of Physics, University of Missouri-Rolla, Rolla, Missouri 65401). Phys. Rev. A 11: No. 4, 1475-1478 (Apr 1975).

Autoionizing levels in cesium, rubidium, and potassium have been studied by electron impact in a crossed-beam apparatus. Comparisons are made with binary-encounter calculations of Roy and Rai. The effects of autoionization and inner-shell ionization have been overestimated in the theory. (auth)

4492 COMMENTS ON THE DEPARTURE FROM THE Z^2 DEPENDENCE IN IONIZATION BY HEAVY PROJECTILES. Hopkins, F.; Brenn, R.; Whittemore, A.R. (Department of Physics, State University of New York, Stony Brook, New York 11794); Cue, N.; Dutkiewicz, V. Phys. Rev. A 11: No. 4, 1482-1484 (Apr 1975).

The yields for sulfur, scandium, iron, and copper K x rays produced in collisions with oxygen and fluorine projectiles have been measured over a large range of impact velocities ($\eta^{1/2} \simeq 0.2$–0.8). These yields, when scaled by the corresponding velocity-matched proton-induced yields, $\sigma\ (Z)/Z^2\sigma\ (1)$, all cross the unity value at $\eta^{1/2}$ above the values suggested in a previous theoretical paper but do approach increased-binding predictions with decreasing $\eta^{1/2}$. (auth)

4493 PHOTOIONIZATION STUDY OF THE REACTION O_2^+ (a^4PI/sub u/) WITH O_2. Dehmer, P. M.; Chupka, W. A. (Argonne National Lab., IL). J. Chem. Phys.; 62: No. 6, 2228-2234(15 Mar 1975).

A high-resolution photoionization study of the production of O^+/sub 3/ from the reaction of O^+/sub 2/ (a^4PI/sub u/) with O_2 determined that the reaction proceeds primarily through the nu' equals 5 to 10 vibrational levels of the O^+/sub 2/ (a^4PI/sub u/) state. The relative reaction cross section for O^+/sub 3/ formation increases rapidly from nu' equals 4 to nu' equals 9, where it is a maximum. For nu' equals 10, the lowest vibrational level for which the reaction O^+/sub 2/ (a^4PI/sub u/) + O_2 yields O^+/sub 2/ + O + O is exothermic, the reaction cross section for observable O^+/sub 3/ is approximately 10 percent smaller than the cross section for nu' equals 9, and for nu' greater than or equal to 11 the cross section is relatively small. A study of the cross section as a function of translational energy showed that internal vibrational energy is significantly more effective than translational energy for product formation for total collision energies of up to approximately 1 eV above threshold. A plausible surface crossing mechanism for the reaction is suggested. The calculated thermodynamic threshold for O^+/sub 3/ production corresponds to a wavelength of 747.2 +- 1.4 A, which nearly coincides with O^+/sub 2/ (a^4PI/sub u/, nu' equals 4) convergence limit at 747.25 A. A very small amount of reaction is observed at this vibrational convergence limit; however, this is due at least in part to the thermal rotational and translational energy of the reactants. (6 figures, 3 tables) (auth)

4494 ELECTRON EXCITATION CROSS SECTIONS FOR NEUTRAL BERYLLIUM ATOMS. Williamson, W. Jr. (Univ. of Toledo); Greene, T. J. J. Chem. Phys.; 62: No. 6, 2515-2517 (15 Mar 1975).

The Born approximation was used to calculate electron excitation cross sections for Be. Simple HSHFS wave functions were used to describe the target atom, and the cross section was calculated up to one hundred threshold units of energy. An asymptotic form of the cross section was used to estimate oscillator strengths for the corresponding transitions. (2 tables) (RWR)

4495 DEVELOPMENTS IN NON-NUCLEAR HEAVY ION PHYSICS. Brown, W. L. (Bell Telephone Labs., Murray Hill, NJ). pp 545-583 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

This survey of recent developments using beams of heavy ions outside the field of nuclear physics is divided into two major parts, atomic physics and solid state science. The atomic structure of one- and two-electron atoms and then multielectron atoms is considered first. Heavy-ion beams have revealed a number of exceedingly interesting aspects of atomic collision processes, including quasi-molecular x rays, multiple collisions, inelastic processes involving ions in high charge states, and special modes of excitation. Heavy ions have been used in condensed materials studies principally in two ways, in investigations of the electromagnetic fields in solids and in alteration of the properties of solids by ion implantation and damage. Channeling and hyperfine fields are aspects of the former which are discussed. The importance of hydrogen-like heavy ions for tests of quantum electrodynamics is also examined. (36 figures, 1 table) (RWR)

4496 K AND L X-RAY PRODUCTION CROSS SECTIONS EXCITED BY 14.00–34.16 MeV ALPHA-PARTICLE BEAMS. Flocchini, R. G. Davis, CA; Univ. of California (1974). 106p. University Microfilms Order No. 75-8331.

Thesis (Ph. D.).

K and L-shell x-ray production cross sections were measured using alpha-particle beams of 14.00 to 34.16 MeV. The K-shell measurements ranged from Z equals 20 to Z equals 50 and included Ca, Sc, Ti, V, Fe, Ni, Cu, Zn, Ga, Br, Rb, Sr, Y, Mo, Ag, In, and Sn while the L-shell measurements ranged from Z equals 55 to Z equals 92 and included Cs, Ba, Ce, Gd, Tm, Lu, Au, Pb, Th, and U. Thin metallic foils were used for the measurements and corrections for self-attenuation were negligible. A liquid nitrogen cooled Si(Li) detector and associated pulsed optical electronics were used in detecting x-rays. Absolute cross sections with an uncertainty of +- 10 percent are presented for the elements measured. Also smoothed cross sections are presented which were generated by a three term polynomial fit of the experimental data points. By use of available fluorescence yields the K-shell data were converted to ionization cross sections and compared to various theoretical models. The data suggest the necessity for high velocity subtractive terms as was suggested by recent theoretical investigations. Results of the comparison with theory are presented. K alpha/K beta and L/sub alpha$_{1,2}$/L/sub 1/ ratios and comparisons with theory are also presented. (Diss. Abstr. Int., B)

4497 CHARGE EXCHANGE OF RARE GAS IONS: AN ION KINETIC ENERGY STUDY. Ast, T.; Terwilliger, D.T.; Beynon, J.H.; Cooks, R.G. (Purdue University, Department of Chemistry, West Lafayette, Indiana 47907). J. Chem. Phys. 62: No. 10, 3855-3863 (15 May 1975).

The charge exchange reaction $m^{+\cdot} + N \rightarrow m^{+\cdot} + N^{+\cdot}$ has been studied at 8 keV impact energy in a double-focusing mass spectrometer for each combination of the rare gas ions and atoms. The kinetic energy gained or lost by the fast species m has been measured and from this the states of $m^{+\cdot}$ and $N^{+\cdot}$ have been assigned. Generally all the observed peaks correlate with known states of the product ions, and the relative intensities of the peaks are in approximate agreement with previously determined cross sections. The Massey "near-resonance" criterion is qualitatively applicable. Extension of the work to the study of polyatomic species is reported. (auth)

4498 D_2–D_2 TOTAL SCATTERING CROSS SECTIONS IN THE VELOCITY RANGE 950–2250 m/sec. Dimoplon, G. (Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Kinsey, J.L. J. Chem. Phys. 62: No. 10, 4116-4120 (15 May 1975).

Measurements of the D_2–D_2 total scattering cross section are reported over the range 950–2250 m/sec in relative speed. The data were fit with a piecewise continuous potential constrained to give the correct theoretical behavior for large intermolecular separations. This potential also gives a satisfactory fit to experimental diffusion coefficients. (auth)

4499 EFFECTIVE POTENTIAL STUDY OF THE ROTATIONAL EXCITATION OF HD BY COLLISION WITH H_2. Chu, S. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80302). J. Chem. Phys. 62: No. 10, 4089-4100 (15 May 1975).

The effective potential formalism of Rabitz is extended to a general potential expressed in terms of relative or body-fixed coordinates and applied to the study of the H_2–HD rotationally inelastic collisions. The H_2 and HD molecules are treated as rigid rotors and their interaction potential is derived from the H_2–H_2 potential. Long-range quadrupole–dipole and quadrupole–quadrupole interactions are also considered. Quantum-mechanical close-coupling calculations for three-dimensional collisions of para-H_2 and ortho-H_2 with HD are performed up to E=0.20 eV. The general features of the rotational excitation cross sections of HD are examined and their sensitivity to certain aspects of the potential are analyzed. In particular, the different roles of the short- and long-range anisotropies are illustrated. It is found that the degree of anisotropy is meaningful only in relation to the magnitude of the "effectively" spherically symmetric part of potential. The rate constants for pure rotational transitions of HD are presented in the temperature range of 5 to 800 °K. The relation of these results to the quantitative interpretation of the thermal balance of interstellar clouds is pointed out. We have also calculated the rotational relaxation times for the lowest two levels of HD, which could be examined and compared with future sound absorption experiments to assess the accuracy of the H_2–HD interaction potential. (auth)

4500 FINE STRUCTURE TRANSITIONS OF C^+ IN COLLISIONS WITH H_2. Chu, S.; Dalgarno, A. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138). J. Chem. Phys. 62: No. 10, 4009-4015 (15 May 1975).

Close-coupling calculations are described of the cross sections for the fine-structure excitation of C^+ in collisions with molecular hydrogen for energies up to 0.2 eV. A table is presented of the cooling rate coefficients for temperatures between 10–1000 °K. (auth)

4501 TEST OF BORN APPROXIMATION ON THE 60 eV AUTOIONIZED TRANSITION IN HELIUM. Dillon, M.A.; Lassettre, E.N. (Department of Chemistry, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). J. Chem. Phys. 62: No. 10, 4240-4241 (15 May 1975).

The 60.3 eV autoionization transition of helium has been studied by electron spectroscopy. The discrepancy between experiment and a theory based on the Born approximation greatly exceeds experimental error. (AIP)

4502 EFFECTS OF THE MULTIPLICITY OF IMPACTS ON VIBRATION–TRANSLATION ENERGY TRANSFER IN COLLINEAR COLLISIONS. Shin, H.K. (Department of Chemistry, University of Nevada, Reno, Nevada 89507). J. Chem. Phys. 62: No. 10, 4130-4137 (15 May 1975).

An idealized model of nonreactive collinear C–B+A collisions has been developed for the calculation of the number of impacts and amount of vibration–translation energy exchange at each impact as functions of the mass distribution and the initial collision energy. The maximum number of impacts that a single collision can have is $n^* = 90°/\phi$, where $\phi = \tan^{-1}[m_B(m_A + m_B + m_C)/m_A m_C]^{1/2}$; for

nonintegral values of $90°/\phi$, $n^* = [90°/\phi]$, where the square brackets denote the algebraically largest integer which just exceeds the nonintegral value $90°/\phi$. The model is applied to the collinear collisions H–F+F, F–H+F, Cl–H+Cl, Br–H+Br, I–H+Cl, and several other hypothetical systems with particular emphasis on the dependence of energy exchange on the number of impacts. Comparison with exact trajectory calculations at high collision energies shows a diminished inelasticity as the result of repeated encounters between A and B in a single collision. (auth)

4503 SURFACE AND VACUUM PHYSICS INDEX. Thesaurus, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 19p.

4504 CHARGE TRANSFER IN HIGH-ENERGY ATOMIC COLLISIONS. Kleber, M. (Technische Univ., Munich); Nagarajan, M. A. J. Phys., B (London); 8: No. 4, 643-648(11 Mar 1975).

In the framework of the distorted-wave Born approximation (DWBA), a simple analytic expression is obtained for electron capture cross sections in high energy collisions. Reasons for the striking agreement between theory and experiment are presented. (auth)

4505 APPLICATION OF CLASSICAL FINITE CHARACTERISTIC COLLISION TIME APPROXIMATION TO IONIZATION OF ATOMIC HYDROGEN BY ELECTRON IMPACT. Bates, D. R.; Snyder, R. (Queen's Univ., Belfast). J. Phys., B (London); 8: No. 3, 411-416(21 Feb 1975).

Ionization of atomic hydrogen by electron impact is treated by the classical finite characteristic collision time approximation (Bates and Snyder, J. Phys. B, Molec. Phys.; 6: 642-52 (1973)). The cross sections obtained by the displacement version are fairly accurate. (auth)

4506 POLARIZATION POTENTIAL IN INELASTIC COLLISIONS. Mohr, C. B. O. (Melbourne Univ., Parkville). J. Phys., B (London); 8: No. 3, 388-392(21 Feb 1975).

Consideration of the effect of target polarization is extended to inelastic collisions. The accuracy of the usual methods of obtaining polarization potentials by the implicit use of perturbation theory is found to be poor, as tested on hydrogen by the more satisfactory, if tedious, method of diagonalization of the energy matrix. (auth)

4507 CALCULATION OF THE R-MATRIX BY ARBITRARY BASIS SETS FOR ONE-CHANNEL ELASTIC ELECTRON–HELIUM SCATTERING. Kracht, D.; Chang, J. J. (Centre Europeen de Calcul Atomique et Moleculaire, Orsay, France). J. Phys., B (London); 8: No. 3, L29-L31(21 Feb 1975).

From the calculations of electron scattering by the helium atom a rule is presented showing how to choose an arbitrary basis set of Slater-type orbitals for the scattering electron such that the R-matrix becomes convergent. (auth)

4508 ELECTRONIC AND IONIC IMPACT PHENOMENA. Volume 5. Slow Positron and Muon Collisions. Massey, H. S. W.; Burhop, E. H. S.; Gilbody, H. B. Oxford; Clarendon Press (1974). 3716p.

Collisions of slow positrons and of slow positive muons in gases; and collision processes involving mesic atoms are considered; and notes are given on advances over the field covered by all volumes of the present edition, during the period since volumes I to IV were completed. Brief contents are: the passage of electrons through gases; experiments with electrons in atomic gases; impact of electrons with atoms and ions; electron collisions with atoms; resonance phenomena; electron collisions with molecules; collisions involving electrons and photons; collisions between atoms and molecules; collisions under gas-kinetic conditions; recombination; elastic collisions between particle beams and neutral atoms and molecules; inelastic collisions between atomic systems; charge changing and ionizing collisions; collisions involving excitation; collisions of slow positrons and of slow positive muons in gases. (UK)

4509 SURFACE AND VACUUM PHYSICS INDEX. Volume 10, No. 1, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 58p.

4510 SURFACE AND VACUUM PHYSICS INDEX. Volume 9, No. 12, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 45p.

4511 SURFACE AND VACUUM PHYSICS INDEX. Volume 10, No. 2, 1975. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1975). 47p.

4512 EFFECT OF THE ELECTRON INITIAL STATE ON THE IONIZATION PROBABILITY AT DIFFERENT IMPACT PARAMETERS. Beloshitsky, V. V.; Nikolaev, V. S. (Moskovskij Gosudarstvennyj Univ. (USSR). Inst. Yadernoj Fiziki). Phys. Lett., A; 51: No. 2, 97-98(10 Feb 1975).

The probability, W, of ionization of hydrogen-like particles in the 1s and 2s states by atomic nuclei has been calculated within the Born approximation at different impact parameters p. Relations between the values of W(p) for the 1s and 2s initial states at the same energies of their binding are compared with the relations between the electron density distributions. Qualitative conclusions are drawn about relative importance of electrons located at different distances from nucleus. (auth)

4513 SINGLE IONIZATION OF Xe BY FAST ELECTRONS IN THE VICINITY OF THE $4d^{10}$ SUBSHELL THRESHOLD. Amusia, M. Ya.; Berezina, N. B.; Chernysheva, L. V. (A. F. Ioffe Physico-Technical Institute, Academy of Sciences of the USSR). Phys. Lett., A; 51: No. 2, 101-102(10 Feb 1975).

The generalized oscillator strength of outer shell excitations has a pronounced maximum in the vicinity of $4d^{10}$ subshell ionization threshold due to virtual excitation of the latter. This phenomenon may be experimentally observed. (auth)

4514 UNREACTIVE ENERGY BANDS IN ATOM–MOLECULE COLLISIONS. Wright, J. S. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Chemistry); Tan, G.; Laidler, K. J. (Ottawa Univ., Ontario (Canada). Dept. of Chemistry); Hulse, J. E. (Toronto Univ., Ontario (Canada). Dept. of Chemistry). Chem. Phys. Lett.; 30: No. 2, 200-203(15 Jan 1975).

Classical trajectory calculations for exchange reactions on the collinear SSMK potential energy surface show the existence of reactive and unreactive regions, or bands. The relationship between trajectory times and band positions is shown. The system T + HT exhibits a striking unreactive band. (auth)

4515 ON THE QUASICLASSICAL APPROACH TO COLLISION THEORY. Manz, J. (Technische Univ. Muenchen (F. R. Germany). Lehrstuhl fuer Theoretische Chemie). Chem. Phys. Lett.; 31: No. 2, 242-244(1 Mar 1975).

The exact equation for the quasiclassical trajectory for atom–diatomic oscillator collisions with linear force interaction and constant harmonic frequency is presented. The example indicates necessary modifications for conventional quasiclassical collision theory. (auth)

4516 R-MATRIX THEORY FOR ELECTRON–ATOM AND ELECTRON–MOLECULE COLLISIONS USING ANALYTIC BASIS SET EXPANSIONS. Schneider, B. (Los Alamos Scientific Lab., N. Mex. (USA)). Chem. Phys. Lett.; 31: No. 2, 237-241(1 Mar 1975).

A formulation of R-matrix theory based on analytic basis set expansions of the internal wavefunction is presented which has several advantages over the more conventional approach. Integral evaluation is simple even for diatomic molecules, the R-matrix boundary condition is incorporated into the hamiltonian, not the basis functions, and single-center expansions are eliminated for non-spherical targets. Results for electron–He scattering are presented and compared with other calculations to illustrate the technique. (auth)

4517 ON THE DECOUPLING OF ANGULAR MOMENTA IN MOLECULAR COLLISIONS. Kouri, D. J. (Houston Univ., Tex. (USA). Dept. of Chemistry). Chem. Phys. Lett.; 31: No. 3, 599-601(15 Mar 1975).

It is pointed out that the more exact treatment of the j_z-conserving coupled states (R-helicity) approximation is quite closely related to the P-helicity method of Tamir and Shapiro, and the two methods lead to approximate equations identical in form. The difference in interpretation of the magnetic quantum numbers in the two methods is used to understand the accuracy of the crudest approximations obtained by neglecting the transformation from rotating to space-fixed coordinate frames. Further it is expected that the two approaches lead to similar results in the case where the exact diagonal elements of the I^3 operator are retained and the correct transformations to non-helicity frames are used. Finally, the two methods should lead to identical results for integral cross sections and opacities. (auth)

4518 EXCITATION CROSS-SECTION OF THE PROTONS COLLIDING WITH HYDROGEN ATOMS. Felden, M. (Nancy-1 Univ., 54 (France). Lab. de Physique des Milieux Ionises). Phys. Lett., A; 51: No. 4, 226-228(10 Mar 1975).

The transition amplitude relative to excitation of the hydrogen atoms by proton impact is determined. The modified correlation approximation is utilized. (auth)

4519 THE STATIONARY PHASE METHOD IN THE UNIFORM WKB THEORY OF INELASTIC SCATTERING. Cho, U. I.; Eu, B. C. (McGill Univ., Montreal, Quebec (Canada). Dept. of Chemistry). Chem. Phys. Lett.; 31: No. 1, 181-185(15 Feb 1975).

When the modified Magnus approximation to the equation of motion in the uniform WKB theory of inelastic scattering is combined with the method of stationary phase for certain integrals,

excellent numerical agreement is obtained between the transition probabilities thus calculated and the corresponding transition probabilities by the numerical solutions of the equation of motion and equivalent Schrödinger equations. The computation time required for calculation of transition probabilities is an order of magnitude less than that for numerical solution of Schrödinger equation by the Runge–Kutta-Gill method. (auth)

4520 SCATTERING EXPERIMENTS WITH HYDROGEN ATOMS: VELOCITY DEPENDENCE OF THE INTEGRAL TOTAL CROSS SECTION WITH SIMPLE MOLECULES IN THE ENERGY RANGE 0.01–1.00 eV (c.m.). Bauer, W.; Bickes, R. W. Jr.; Lantzsch, B.; Toennies, J. P.; Walaschewski, K. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen (F. R. Germany)). Chem. Phys. Lett.; 31: No. 1, 12-16(15 Feb 1975).

Integral total cross sections for hydrogen atoms scattered by H_2, D_2, N_2, CO, NO, O_2, CO_2, C_2H_2 have been measured for H atom velocities in the range 1.2 to 13.4×10^5 cm s^{-1} ($0.007 \lesssim E_{c.m.} \lesssim 0.94$ eV). The data have been fitted to a Lennard–Jones (12,6) model potential for which the product of the potential well parameters, ϵR_m, was determined (ϵ is the well depth and R_m the location of the potential minimum). Separate values for ϵ and R_m are estimated by using a combination rule procedure tested in earlier work on H–rare gas scattering. (auth)

4521 TRAJECTORY CALCULATION RESULTS ON THE ORIENTATION OF A DIATOMIC MOLECULE IN COLLISION WITH AN ATOM. Kistemaker, P. G.; Vries, A. E. de (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). Chem. Phys. Lett.; 31: No. 1, 17-20(15 Feb 1975).

Orientational effects in collisions between a diatomic molecule and a noble gas atom are studied by classical trajectory calculations. A preferable "perpendicular orientation" of the molecule is found at the moment of closest approach of the atom. This orientational effect is more pronounced in collisions with heavy atoms. (auth)

Atomic Theory

Refer also to abstract 4439, 5134, 5231, and 5257.

4522 COMPUTATION OF ATOMIC MANY-ELECTRON INTEGRALS USING A MARKOV CHAIN GENERATED MONTE CARLO METHOD. Gibbs, R.L.; Dunn, T. (Department of Physics, Louisiana Tech University, Ruston, Louisiana 71270). J. Chem. Phys. 62: No. 9, 3454-3457 (1 May 1975).

A Monte Carlo method for evaluating complicated many-electron integrals is described. The process utilizes a Markov chain which properly chooses configurations of electrons in accordance with the form of Ψ chosen. The method inherently reduces the variance compared to the classical Monte Carlo method. Some explicit examples are shown for a four-electron system. (auth)

4523 OPTIMIZED EXPONENTS IN MINIMUM BASIS ATOMIC GROUND STATE WAVEFUNCTIONS. Weltin, E.E. (Department of Chemistry, University of Vermont, Burlington, Vermont 05401). J. Chem. Phys. 62: No. 9, 3546-3548 (1 May 1975).

The dependence on the nuclear charge of exponents minimizing the total energy of minimum-basis ground-state wavefunctions for first- and second-row atoms and some Ne-like and Ar-like ions is examined. Excellent linear correlations are found with correlation coefficients better than 0.999. Interpretation within a model of screened nuclear charges suggests, in agreement with the classical Slater rules, that *s* and *p* electrons with the same *n* are grouped together and that screening due to outer-shell electrons is negligible. In disagreement with these rules, it is found that a multiplying factor different from unity is necessary for 2*s* and 3*s* exponents to correct for deficiencies in the functional form of the *ns* atomic orbitals. (auth)

4524 DENSITY FUNCTIONAL THEORY OF INTERACTING CLOSED SHELL SYSTEMS. II. THE DETERMINATION OF CHARGE DENSITIES AND THE HELLMAN-FEYNMAN THEOREM. Harris, R.A.; Heller, D.F. (Department of Chemistry, University of California, Berkeley, California 94720). J. Chem. Phys. 62: No. 9, 3601-3604 (1 May 1975).

The density functional formalism and the additive density approximation are used to obtain the nonadditive contribution to the electron density of a set of closed shell atoms in the absence of external fields. It is shown that, due to the additive density approximation, the Hellman–Feynman theorem is violated when the force on the nucleus is examined. The reason for this violation is discussed. (auth)

4525 DISPERSION ENERGIES IN SYSTEMS OF TWO CLOSED SHELL ATOMS AND/OR IONS. Winslow, G.H. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 62: No. 10, 4138-4145 (15 May 1975).

A semiempirical device for the calculation of the coefficients in the dispersion energy expansion for interaction between two closed shell atoms or ions is described. Summation is over all electrons. Averages of powers of electron radial coordinates are calculated with Slater-type functions. Effective quantum numbers and screening constants were determined so as to reproduce a set of like-atom rare gas dipole–dipole coefficients. These are used to extend the calculations to coefficients for unlike rare gas and ion–ion interactions, to higher multipole coefficients for those interactions, and to polarizabilities and diamagnetic susceptibilities. The effective one-level energies, numbers of polarizable electrons, and accuracy of combination rules, all as determined by these calculations, are examined. Since the principal interest here is extension to ionic crystals, discussion of a questionable lattice sum for dipole–dipole interactions is appended. (auth)

4526 A GENERAL PROGRAM TO CALCULATE THE MATRIX OF THE SPIN-ORBIT INTERACTION. Klotz, W. D. (Technische Univ. Berlin (F. R. Germany)). Comput. Phys. Commun.; 9: No. 2, 102-116(Feb 1975).

In atomic structure calculations with configuration interaction, one has to evaluate the matrix of the Hamiltonian with respect to a basis set of configuration wave functions. For configurations with several open shells, the calculation of the matrix elements becomes cumbersome. A general program, which calculates the two-body part of the Hamiltonian, exists already. A program is presented which calculates the one-body spin-orbit interaction. (auth)

4527 DOUBLE PERTURBATION THEORY AND SYMMETRY. Amos, A. T.; Yoffe, J. A. (Nottingham Univ. (UK)). Chem. Phys. Lett.; 31: No. 1, 53-56(15 Feb 1975).

A formulation of double perturbation theory is described which allows symmetry to be included in those cases where the zero-order Hamiltonian does not contain the full symmetry of the problem. As an example the theory is applied to the Epstein–Johnson spin model. (auth)

4528 THE FROST MODEL AND PERTURBATION THEORY. Amos, A. T.; Yoffe, J. A. (Nottingham Univ. (UK)). Chem. Phys. Lett.; 31: No. 1, 57-60(15 Feb 1975).

Symmetry-adapted double perturbation theory is applied to the Frost model. Even when used only through zero-order in the correcting "internal perturbation, it gives values of average electric polarizabilities in fair agreement with experiment. If the model is extended by employing elliptical Gaussians rather than spherical ones, the anisotropy of the molecular polarizability can be determined. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

4529 RAREFIED MHD LAMINAR RADIAL CHANNEL FLOW. Khader, M. S. (Cairo Univ. (Egypt)); Goodling, J. S.; Vachon, R. I. (Auburn Univ., Ala. (USA). Dept. of Mechanical Engineering). Appl. Sci. Res. (The Hague); 30: No. 2, 127-143(Dec 1974).

The steady axisymmetrical laminar flow of slightly rarefied electrically conducting gas between two circular parallel disks in the presence of a transverse magnetic field is analytically investigated. A solution is obtained by expanding the velocity and the pressure distribution in terms of a power series of 1/r. The effect of rarefaction is taken to be manifested by slip of the velocity at the boundary. Velocity, induced magnetic field, pressure and shear stress distributions are determined and compared with the case of no rarefaction. (auth)

4530 MAGNETOHYDRODYNAMIC PIPE FLOW WITH REVERSE MOTION. Ranger, K. B. (Toronto Univ., Ontario (Canada). Dept. of Mathematics). Appl. Sci. Res. (The Hague); 30: No. 2, 81-92(Dec 1974).

An exact solution of the magnetohydrodynamic pipe flow equations is found in terms of elementary functions. As the Hartmann number increases from zero, reverse motion in the pipe occurs and eventually separates from the boundary. With further increase in the Hartmann number the velocity on the boundary continuously changes sign and the flow is analogous to laminar separation in field free hydrodynamics. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 5244.

4531 (JINR-E1-8559) REGULARITIES OF STRANGE PARTICLE PRODUCTION IN HIGH ENERGY COLLISIONS. Berceanu, S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 32p. Dep. NTIS (US Sales Only) $4.75.

Available data on total strange particle production cross sections ($K\bar{K}$ and $Y^{*}K$) from $\pi^{+}p$ and pp collisions are surveyed. Fits and comments on the change with energy of average multiplicities of π^{+}, K^{+}, $\bar{p}$, Λ/Σ^{*}, $K^{*}/\bar{K}^{*}$ from pp collisions and Λ/Σ^{*}, $K^{*}/\bar{K}^{*}$ from $\pi^{-}p$ collisions are presented. With generating functional formalism for strange particle production and general model-independent assumptions, some expected asymptotic properties of the conditional charge distributions with strange particle production are pointed out. (auth)

4532 (JINR-E1-8679) "DIRECT" NEUTRINO PRODUCTION AND CHARMED PARTICLES. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

It is shown that it is feasible to detect electron neutrinos emitted by charmed particles in neutrino experiments characterized by the absence of the pion and kaon decay region. The absolute intensity of the effect looked for in such experiments is small, but the background is not large. (auth)

4533 (LNF-74/40(R)) FRASCATI-TORINO COSMIC RAY UNDERGROUND EXPERIMENTS. A Progress Report. Baschiera, B.; Bergamasco, L.; Briatore, L.; Castagnoli, C.; Dardo, M.; D'Ettorre Piazzoli, B.; Mannocchi, G.; Picchi, P.; Sitte, K.; Visentin, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 15 Nov 1974. 78p. Dep. NTIS (US Sales Only) $7.00.

The present status and perspectives of the collaboration between the two groups performing theoretical and experimental cosmic ray research is discussed. A collaborative program for a series of experiments at shallow and high depths underground was developed. (JFP)

4534 (UCLA-10P25X2) PARTICLE PHYSICS. Annual Progress Report. (California Univ., Los Angeles (USA)). Nov 1974. Contract AT(11-1)-GEN-10. 16p. Dep. NTIS $4.00.

Research on particle physics at medium energy is summarized. Pion–nucleon and nucleon–nucleon interactions, investigations of the fundamental symmetry, such as time reversal invariance and SU(3), selection rules and their underlying theories, for example the quark model, and electromagnetic interactions as a probe of strong interactions are included. (JFP)

4535 (UCSB-10P23-17) HIGH ENERGY USER GROUP AT SANTA BARBARA. Progress Report, May 1974–March 1975. Caldwell, D. O. (California Univ., Santa Barbara (USA). Dept. of Physics). 1975. Contract AT(11-1)-GEN-10. 14p. Dep. NTIS $4.00.

A summary of research on experimental high energy physics is presented. A list of publications is included. (JFP)

4536 (UCSC-34P197X3) EXPERIMENTAL RESEARCH IN HIGH ENERGY PHYSICS. Progress Report. Heusch, C. A. (California Univ., Santa Cruz (USA)). 1974. Contract AT(04-3)-34. 10p. Dep. NTIS $4.00.

Experimental research on experimental high energy physics is summarized. A list of publications is included. (JFP)

4537 (UH-511-187-75) ANNUAL PROGRESS REPORT OF THE HIGH ENERGY PHYSICS GROUP. Peterson, V. Z.; Tuan, S. F. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). 15 Nov 1974. Contract AT(04-3)-511. 95p. Dep. NTIS $7.75.

Experimental and theoretical research in high energy physics is summarized. A list of publications is included. (JFP)

Electromagnetic

Refer also to abstracts 3594 and 4892.

4538 (JINR-P3-8442) POSSIBLE SENSITIVITY INCREASE OF THE INSTALLATION FOR NEUTRON ELECTRIC DIPOLE MOMENTUM MEASUREMENT BY MEANS OF ULTRACOLD NEUTRONS. Taran, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 11p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A possibility is discussed of increasing the sensitivity of the installation for measuring a neutron electric dipole momentum using ultracold neutrons in the storage variant due to the introduction of the moving polarizer. It is shown that the doubling of the statistic can be achieved for the installation "Tristom." (auth)

4539 (UCLA-10P17-X2) ARTICLE II. Review of Current Activities. Progress Report. (California Univ., Los Angeles (USA)). 1972. Contract AT(11-1)-GEN-10. 13p. Dep. NTIS $4.00.

Experimental research on meson properties is summarized. (JFP)

4540 SEARCH FOR SHORT-PERIOD PENETRATING PARTICLES. Blagov, M. I.; Komar, A. A.; Murashova, V. A.; Syreishchikova, T. I.; Tel'nov, Yu. Ya.; Yakimenko, M. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 21: No. 2, 300-307(Feb 1975). (In Russian).

The Lebedev Physical Institute synchrotron with a maximum energy of 650 MeV was used to search for the charge-one short-period penetrating light particles produced in pairs in an iron target irradiated by the bremsstrahlung beam from the synchrotron. The experimental results exclude the existence of spinor (scalar) particles with masses from two electron masses (the own lifetime is higher than $2.8 \cdot 10^{-11}$ ($5 \cdot 10^{-11}$ sec)) up to 13 (10.6) electron masses (the own lifetime is higher than $2 \cdot 10^{-10}$ sec). (auth)

4541 RECOIL PROTON POLARIZATIONS IN NEUTRAL PION PHOTOPRODUCTION NEAR 63°, 1.0 TO 1.8 GeV. Castro, M. M. Medford, MA; Tufts Univ. (1974). 239p. University Microfilms Order No. 74-28,545.

Thesis (Ph. D.).

Measurements are presented of the recoil-proton polarization for pi^{0} photoproduction angles near 63° in the c.m. system. The experiment was performed at the Cambridge Electron Accelerator Laboratory, and utilized a large carbon-plate spark chamber as polarization analyzer. About 160,000 events were collected in the incident photon energy range from 900 to 1800 MeV. Film measurements were accomplished with the aid of an automatic film scanner, SPASM. The transformation to real space was revised to remove discontinuities present in an older version of this analysis. Proton trajectories were determined by weighing more heavily sparks nearer the interaction vertex. The data were subjected to various selection constraints to improve quality, and were further renormalized to minimize effects of systematic errors. Polarizations were computed using a maximum likelihood function and existing analyzing power data. Tests were made to show the sensitivity of the measured polarization to various possible data treatments. The steep angular dependence observed by other experimenters at lower energies persists to at least 1500 MeV, and the polarization crosses through zero near 63° over the entire 900 to 1600 MeV range. Summary fits are made to available recoil-proton polarization data, 950 to 1250 MeV, and are found to require terms of order cos³ theta, but no higher. (Diss. Abstr., Int., B)

4542 MEASUREMENT OF THE CASCADE TIME OF Σ^{-} IN LIQUID HELIUM. Fetkovich, J. G.; McKenzie, J.; Riley, B. R.; Wang, I. T. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Nucl. Phys., A; 240: No. 3, 485-492(24 Mar 1975).

In a study of $\Sigma^{-}\pi^{+}$ production by stopped K^{-} in liquid helium, $(19 \pm 6)\%$ of stopped Σ^{-} were observed to decay. This corresponds to a "cascade time" of 28 ± 8 psec. (auth)

4543 POLARIZED TARGET ASYMMETRY IN π^{0} PHOTOPRODUCTION BETWEEN 0.4 AND 1.0 GeV AROUND 100 deg. Feller, P.; Fukushima, M.; Horikawa, N.; Kajikawa, R.; Mori, K.; Nakanishi, T.; Ohshima, T.; Pak, C. O.; Saito, M.; Suzuki, S. (Nagoya Univ. (Japan). Dept. of Physics). Phys. Lett., B; 55: No. 2, 241-244(3 Feb 1975).

The polarized target asymmetry in the reaction $\gamma p \rightarrow \pi^{0}p$ was measured at c.m. angles around 100° for photon energies between 0.4 and 1.0 GeV by detecting both the recoil proton and the π^{0}. The result is compared with recent analyses. (auth)

Weak

Refer also to abstracts 4657 and 4968.

4544 (COO-3071-127) INVARIANT MASS DISTRIBUTIONS FROM HIGH ENERGY INELASTIC NEUTRINO AND ANTINEUTRINO INTERACTIONS. Benvenuti, A.; Cline, D.; Mann, A. K. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 1974. 14p. Dep. NTIS $4.00.

The measured distributions in invariant mass W of the recoiling hadron systems in neutrino- and antineutrino-nucleon inelastic collisions are observed to be significantly different after taking into account the opposite helicities of neutrinos and antineutrinos. These distributions indicate the onset of a new phenomenon in the antineutrino data beginning at an incident energy of about 30 GeV, which appears as an excess of events with W greater than 4 GeV/c^2. (auth)

4545 (DESY-L-Ueb-191) SHAPE OF TOTAL CROSS SECTION OF NEUTRINO–NUCLEON INTERACTION AT HIGH ENERGIES. Volkova, L. V.; Zatsepin, G. T. Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1064-1065(1974). 3p. (In German). INIS.

The total effective cross-section for the neutrino–nucleon interaction at high energies, $\sigma(\nu,N) = \sigma_0 E(\nu)$, is obtained from an analysis of the muons produced by cosmic neutrinos. The result, $\sigma_0 = (0.55 \pm 0.15) \times 10^{-38}$ cm^2/nucleon, agrees within the margin of error with the value found using the accelerator (CERN). (GE)

4546 MEASUREMENT OF THE FORM FACTOR RATIO g_1/f_1 IN LAMBDA BETA DECAY. Innes, W. R. La Jolla, San Diego, CA: Univ. of California (1974). 167p. University Microfilms Order No. 75-9484.

Thesis (Ph. D.).

The beta decay of 306 polarized lambdas was observed. The lambdas, which had a mean polarization of 70 percent, were produced by a 1.06 GeV/c pi minus beam incident on a CH_2 target. The lambda decay particle trajectories were measured with a solenoidal magnetic spectrometer utilizing spark chambers with magneto strictive readout. The beta decays were differentiated from other decay modes with an isobutane threshold Cherenkov counter. Using only information which depended upon the polarization, g_1/f_1 was found to be $0.44^{+.20}_{-.13}$. Using only information independent of the polarization, g_1/f_1 was found to be $0.62^{+.17}_{-.14}$. Combining all information yielded a value for g_1/f_1 of $0.56^{+.12}_{-.11}$. Although these results taken by themselves are consistent with the Cabbibo theory prediction of 0.69, when combined with previous experiments there is a possibly significant discrepancy in the polarization dependent results. (Diss. Abstr. Int., B)

4547 CONTINUATION OF THE SEARCH FOR T–INVARIANCE VIOLATION IN β DECAY OF A FREE NEUTRON. Erozolimskii, B.G.; Mostovoi, Yu.A.; Fedunin, V.P.; Frank, A.I.; Khakhan, O.V. JETP Lett. 20: No. 11, 345-346 (5 Dec 1974).

A new facility with a high–power beam of polarized neutrons was used to continue the measurements of the three–vector correlation that violates time parity. A value $D = -0.0027 \pm 0.0033$ is obtained for the constant. The measurements are being continued. (auth)

4548 NEW MEASUREMENT OF (g – 2) OF THE MUON. Bailey, J. (Science Research Council, Daresbury (UK). Daresbury Nuclear Physics Lab.); Borer, K. (Bern Univ. (Switzerland) Physikalisches Inst.); Combley, F. (Sheffield Univ. (UK). Dept. of Physics); Drumm, H.; Eck, C.; Lange, F. (Mainz Univ. (F. R. Germany). Inst. fuer Physik); Farley, F. J. M. (Royal Military Coll. of Science, Shrivenham (UK)); Field, J. H.; Flegel, W.; Krienen, F. Phys. Lett., B; 55: No. 4, 420-424(3 Mar 1975).

The g-factor anomaly, $a \equiv (g-2)/2$, has been measured for μ^+ in the new Muon Storage Ring at CERN. The result is $a = (1,165,895 \pm 27) \times 10^{-9}$. This is $(13 \pm 29) \times 10^{-9}$ below the theoretical value which includes sixth-order QED terms and a hadronic contribution of $(73 \pm 10) \times 10^{-9}$. (auth)

4549 A MEASUREMENT OF $K^+_{e\nu\gamma}$ DECAY. Heard, K. S.; Heintze, J.; Heinzelmann, G.; Igo-Kemenes, P.; Kalbreier, W.; Mittag, E.; Rieseberg, H.; Schuerlein, B.; Siebert, H. W.; Soergel, V. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 55: No. 3, 324–326(17 Feb 1975).

The decay $K^+ \rightarrow e^+\nu\gamma$ has been observed. In a counter experiment at CERN, 56 events of this type have been identified by detection of a γ with an energy >100 MeV and of an e^+ with an energy between 236 MeV and the maximum e^+ energy, 247 MeV. The angle between γ and e^+ was >120°. Thus, the experiment was sensitive only to the structure decay (SD) term proportional to the squared sum of vector and axial-vector amplitudes, $|\nu_K + a_K|^2$, corresponding to the emission of right handed γ. It is found that $\Gamma_+(SD)/\Gamma(K_{e2}) = 1.05^{+0.35}_{-0.30}$ and $\Gamma_-(SD)/\Gamma_+(SD) < 85$ (90% CL). Γ_+ is in agreement with theoretical predictions. (auth)

4550 A MEASUREMENT OF THE $(K^+ \rightarrow e^+\nu)/(K^+ \rightarrow \mu^+\nu)$ BRANCHING RATIO. Heard, K. S.; Heintze, J.; Heinzelmann, G.; Igo-Kemenes, P.; Kalbreier, W.; Mittag, E.; Rieseberg, H.; Schuerlein, B.; Siebert, H. W.; Soergel, V. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 55: No. 3, 327-330(17 Feb 1975).

The branching ratio $R = \Gamma(K^+ \rightarrow e^+\nu)/\Gamma(K^+ \rightarrow \mu^+\nu)$ has been measured on the basis of 534 observed $K^+ \rightarrow e^+\nu$ decays. The K^+ decay at rest; the momenta of the e^+ and μ^+ are measured in a magnetic spectrometer using multiwire driftchambers, and the electrons are identified in a gas Cherenkov counter. The result is $R = (2.37 \pm 0.17) \times 10^{-5}$. The value predicted for pure axial-vector interaction and μ-e universality is $R = 2.57 \times 10^{-5}$. (auth)

4551 G_A/G_V MEASURED IN THE DECAY OF POLARIZED NEUTRONS. Krohn, V. E.; Ringo, G. R. (Argonne National Lab., Ill. (USA)). Phys. Lett., B; 55: No. 2, 175–177(3 Feb 1975).

A measurement of $|G_A/G_V|$ in the decay of polarized neutrons, basically quite similar to the 1968 one, gives a value of 1.258 ± 0.015. The asymmetry coefficient, A, is -0.113 ± 0.006. These results include the 1968 data. (auth)

Strong (Baryon-induced)

Refer also to abstracts 4723, 4807, and 4951.

4552 (CONF-750307-1) HADRON PRODUCTION AT 0.8 MRAD BY 300 GeV PROTONS INCIDENT ON A THICK ALUMINUM TARGET. Aubert, B.; Benvenuti, A.; Cline, D. (National Accelerator Lab., Batavia, Ill. (USA)). 1975. 13p. Dep. NTIS $4.00.

From international colloquium of the CNRS on neutrino physics at high energy; Paris, France (18 Mar 1975).

Hadron (pi/sup +-/, K/sup +-/, p, anti p) production was measured by using the Fermilab muon beam as a double-bend spectrometer, with the addition of threshold Cerenkov counters for particle identification. The measurement was made at 0.8 mrad with 300-GeV protons incident on a thick aluminum target. (auth)

4553 (JINR–D3-7991, pp 100-131) MEASUREMENTS OF THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Miller, P. D. (Oak Ridge National Lab., TN). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The historical background behind measurements of the neutron electric dipole moment is recalled. Then the measurement methods and experimental results are described. These include the basic ideas behind the measurement, a description of the hardware, and compilation of results; in particular, the ORNL–Grenoble experiment is discussed. Theoretical estimates of the neutron electric dipole moment are reviewed, and the possibility of using ultracold neutrons in a more sensitive measurement is examined. (6 figures) (RWR)

4554 (JINR–D3-7991, pp 132-134) POSSIBILITY OF A NEW DETERMINATION OF THE MAGNETIC MOMENT OF THE NEUTRON. Miller, P. D. (Oak Ridge National Lab., TN). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

An experiment which can measure the neutron magnetic moment is described. A number of errors can be compensated by reversing the entire apparatus end for end. (RWR)

4555 (JINR-P1-8441) ANALYSIS OF THE SPECTATOR ANGULAR DISTRIBUTIONS IN dp → ppn REACTION AT 3.3 GeV/c. Aladashvili, B. S.; Badelek, B.; Glagolev, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 21p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The experimental nucleon–spectator polar angular distributions obtained in the simplest nuclear reaction dp →ppn at the momentum of incident deuterons 3.3 GeV/c by means of the JINR 1 m liquid hydrogen bubble chamber. Technique peculiarities of the experiment and selection criteria of the reaction dp → ppn are given in previous work. To compare the experimental spectator angular distributions in antilab. system with theoretical calculations in a momentum approximation, one should take into account the following: If the momentum of recoil nucleon is of the same order of magnitude as that of spectator, there appears ambiguity in determining the spectator particle. That is why in the calculations, together with the conventional polar diagram, one takes into account another one in which the spectator particle and the recoil nucleon are removed. The interaction of two nucleons in the final state is also taken into account for an effective radius approximation. The wave function of the deuteron ground state

is taken as a McGee function, the D-state contribution being neglected. The calculations for various intervals of the spectator momentum and 4-momentum transfer are denoted by curves and their comparison with the experimental data is shown. (auth)

4556 (JINR-P1-8539) SEARCH FOR DELAYED HIGH ENERGY RADIATION FROM Pb TARGET IRRADIATED BY 45 GeV PROTONS. Alekseev, G. D.; Zaitsev, A. M.; Kalinina, N. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A search was performed for delayed gamma-quantum or electron radiation which can appear in the decay of hypothetical long-lived particles produced in collisions of 45-GeV protons with Pb nuclei. The lifetime region from 0.1 sec to a day was investigated. The delayed radiation effect was not observed. The values of the upper limit of the cross section for quasi-radioactive nucleus production were obtained to be of the order of 10^{-34} cm^2 for Pb nucleus. (auth)

4557 (UCI-34P149X3) HIGH ENERGY PHYSICS STUDY. Progress Report, October 1, 1973–September 30, 1974. Condon, P.; Schultz, J. (California Univ., Irvine (USA). Dept. of Physics). 1974. Contract AT(04-3)-34. 18p. Dep. NTIS $4.00.

Progress is reported on research conducted by the High Energy Physics Group of the University of California, Irvine during the contract year beginning October 1, 1973. Work was performed on three major projects: analysis and preparation of reports on a study of proton-antiproton interactions between 0.7 and 1.1 GeV/c incident antiproton momentum; analysis of an exposure in the 30 inch BNL chamber with deuterium fill and antiprotons beam; and small angle K/sub L/^{0}p and K/sub L/^{0}d scattering using a hybrid spark chamber/bubble chamber apparatus at the Stanford Linear Accelerator. (auth)

4558 PRODUCTION OF Δ (1236) IN *pp* COLLISIONS AT HIGH ENERGIES. DeBrion, J.P.; Bromberg, C.; Ferbel, T.; Jensen, T.; Schindler, R.; Slattery, P. (University of Rochester, Rochester, New York 14627); Seidl, A.A.; Vander Velde, J.C. Phys. Rev. Lett. 34: No. 14, 910-913 (7 Apr 1975).

We present a comparative study of inclusive $\Delta^{++}(1236)$ production in *pp* collisions at 102 and 400 GeV/*c*. To better than 10% accuracy the invariant $\Delta^{++}(1236)$ cross section does not depend on energy. A remarkable similarity is observed between the properties of the neutral-baryon system produced in association with the $\Delta^{++}(1236)$ and the known characteristics of $\pi^- p$ collisions. (auth)

4559 DEPENDENCE OF TRANSVERSE-MOMENTUM DISTRIBUTIONS OF π^-'s ON $P_\perp$ OF A PROTON IN *pp* INTERACTIONS AT 28.5 GeV/*c*. Clifford, T.S.; Lazarus, E.; Larson, G.P.; Schreiner, W.N.; Schübelin, P.; Turkot, F.; von Lindern, L. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. Lett. 34: No. 15, 978-981 (14 Apr 1975).

We present transverse-momentum distributions of π^-'s produced in the reaction $p_1 p_2 \to p_3 X$ at 28.5 GeV/*c* observed by the Multiparticle Argo Spectrometer System. As the transverse momentum of the trigger proton p_3 is raised from 0.4 to 1.6 GeV/*c* we find that the shape of the π^- momentum distribution *normal* to the (p_1,p_3) plane remains unchanged. The shape of the distribution *in* the plane is also relatively constant but the distribution shifts to balance transverse momentum. (auth)

4560 LIMIT ON THE PRODUCTION CROSS SECTION FOR MASSIVE LEPTONS. Bintinger, D.; Curry, J.; Pilcher, J.; Zylberstejn, A. (The Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637); Cheng, D.; Rubbia, C.; Sulak, L.; Ford, W.; Mann, A.K.; Benvenuti, A.; Cline, D.; Imlay, R.; Wanderer, P. Phys. Rev. Lett. 34: No. 15, 982-985 (14 Apr 1975).

We have searched for heavy penetrating particles produced in nucleon-nucleon interactions with incident energies between 30 and 300 GeV. From a study of the transverse-momentum range between 1.0 and 2.25 GeV/*c* at a laboratory angle of 91 mrad, we conclude that the Lorentz-invariant production cross section is less than 6.4×10^{-35} cm^2 GeV/ (GeV/*c*)^3 for stable particles in the mass range 1 to 5 GeV/*c*^{2}. For unstable particles this limit must be reduced, but because of the compact detector significant limits can still be achieved for lifetimes in the nanosecond region. (auth)

4561 SPIN-PARITY ANALYSIS OF $\pi\pi$ SYSTEMS PRODUCED IN $pp \to pp\pi^+\pi^-$ AND THE QUESTION OF DOUBLE POMERON EXCHANGE. Rushbrooke, J. G.; Webber, B. R. (Cambridge Univ. (UK). Cavendish Lab.). Nucl. Phys., B; 88: No. 1, 145-170(17 Mar 1975).

Data on the reaction $pp \to pp\pi^+\pi^-$ in the momentum range 6 to 25 GeV/*c* are analyzed for features indicating double pomeron exchange (DPE). The moments of the $\pi\pi$ angular distributions are examined in the quasi three-body frame of reference which is analogous to the s-channel helicity frame for quasi two-body processes. Inequality constraints on the moments are shown to suggest the presence of both S and P waves of the $\pi\pi$ system in the relevant pp ($\pi\pi$) kinematic region, arguing against the dominance of DPE. The energy dependence of cross sections for selected events in different ranges of $\pi\pi$ mass is shown to be in accord with the predictions of a double Regge exchange model incorporating pomeron–reggeon exchange and not DPE. Both the cross sections and the $\pi\pi$ angular distributions are also examined in the light of a reggeized one-pion exchange model. (auth)

4562 PRODUCTION OF NUCLEON RESONANCES BY SINGLE DIFFRACTION DISSOCIATION AT THE CERN ISR. Webb, R.; Trilling, G.; Telegdi, V.; Strolin, P.; Shen, B.; Schlein, P.; Rander, J.; Noroska, B.; Meyer, T.; Marsh, W. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.). Phys. Lett., B; 55: No. 3, 331-335(17 Feb 1975).

The single diffraction dissociation process $pp \to (p\pi^+\pi^-)p$ has been studied at the CERN ISR at $\sqrt{s} = 45$ GeV and $0.1 < -t < 0.6$ GeV^2. The reaction is dominated by nucleon resonance production: $pp \to pN(1520)$ and $pp \to pN(1688)$ with cross sections (0.25 ± 0.08) mb and (0.56 ± 0.19) mb, respectively. (auth)

4563 DOUBLE DIFFRACTION DISSOCIATION AND TEST OF POMERON FACTORIZATION AT THE CERN ISR. Webb, R.; Trilling, G.; Telegdi, V.; Strolin, P.; Staude, A.; Shen, B.; Schlein, P.; Rander, J.; Naroska, B.; Muller, F. (Technische Hochschule Aachen (F. R. Germany). 3. (Physikalisches Inst.). Phys. Lett., B; 55: No. 3, 336-340(17 Feb 1975).

The observation of double diffraction dissociation in the process $p + p \to (p\pi^+\pi^-) + X$ at $\sqrt{s}$ of 45 GeV and momentum transfer in the $-t$ range $0.15-0.53$ GeV^2 at the CERN ISR is reported. The relative rates for elastic, single and double dissociation reactions measured here are found to agree with the prediction of Pomeron factorization. (auth)

4564 MEASUREMENT OF LARGE TRANSVERSE MOMENTUM POSITIVE PARTICLES PRODUCED AT MEDIUM ANGLES AT $\sqrt{s}$ = 52.5 GeV. Cottrell, R.; Della Negra, M.; Drijard, D.; Fischer, H. G.; Fontaine, G.; Frehse, H.; Ghesquiere, C.; Hanke, P.; Innocenti, P. G.; Isenbeck, W. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 55: No. 3, 341-344(17 Feb 1975).

The inclusive spectrum of positive particles has been measured at the ISR energy $\sqrt{s}$ = 52.5 GeV as a function of transverse momentum, p_T, for large p_T values using the Split Field Magnet facility. The angular dependence of the distribution is observed and discussed in the range $9° \le \theta^* \le 21°$. An upper limit for the production of the ϕ meson with $p_T \ge 3$ GeV/*c* is derived from the same sample of data. (auth)

4565 STUDY OF CORRELATION EFFECTS IN HIGH-MULTIPLICITY PROTON–PROTON REACTIONS AT 12 AND 24 GeV/*c*. Blobel, V.; Fesefeldt, H.; Hellwig, B.; Moenke-meyer, D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)); Freund, P.; Lamsa, J. W.; Lueers, D.; Schmitz, N.; Schwarzschild, B. M. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (F. R. Germany)); Geich-Gimbel, C. Nucl. Phys., B; 88: No. 1, 18-40(17 Mar 1975).

Correlations in multiparticle final states from pp interactions at 12 and 24 GeV/*c* are studied. In an attempt to distinguish true dynamical correlations from the consequences of kinematics together with P_T damping and the leading-particle effect, the data are compared with an independent-emission model which reproduces the single-particle spectra and also with a model that simulates a fragmentation mechanism. The forward-backward particle configurations and in particular the multiplicity imbalance and charge transfer, defining forward-backward by the largest rapidity gap as well as simply by c.m.s. hemispheres are investigated. Clustering is also studied by looking at distributions of the dispersions in longitudinal rapidity. From the comparison of the data with the models clear evidence is found for dynamical correlations of a sort one would expect from fragmentation-type mechanisms. Indications of nonfragmentation formation of neutral meson clusters are also found. (auth)

4566 EXCHANGE MECHANISMS AND ENERGY DEPENDENCE OF ISOSPIN AMPLITUDES FOR THE REACTION $pN \to NN\pi$ IN THE ENERGY RANGE 5-1480 GeV. Dahl-Jensen, E.; Dahl-Jensen, I.; Hansen, J. D.; Moellerud, R. (Niels Bohr Institutet, Copenhagen (Denmark)); Maekelae, J.; Pimiae, M. (Helsinki Univ. (Finland). Dept. of Nuclear Physics); Sundell, E. (Aabo Akademi, Turku (Finland). Dept. of Physics); Bakken, V.; Haldorsen, J.; Jacobsen, T. Nucl. Phys., B; 87: No. 3, 426-444(10 Mar 1975).

Data on the reactions $pp \to pp\pi^0$, $pp \to pp\pi^+$ and new data on $pn \to pp\pi^-$ at 19 GeV/*c* are used to study the reaction $N_1N_2 \to N_3(N_4\pi)$ in terms of the three isospin amplitudes M^I_χ, where I_χ

and I are the isospins of the exchanged particle and the $N_i\pi$ combination respectively. The result is that the amplitude with isospin zero exchange is dominating at 19 GeV/c. Analysis of available data from 5 to 1480 GeV yields that the isoscalar amplitude $M_{t_3}^0$ is interpreted to be dominated by pomeron exchange and the isovector amplitude $M_{t_3}^1$ by π exchange. The isovector amplitude $M_{t_3}^1$ seems to be a mixture of $A_2(2\rho)$ and π exchanges. The only interference term which is definitely nonzero, is the one between $M_{t_3}^0$ and $M_{t_3}^1$ which is large in magnitude and negative. (auth)

4567 COMPARATIVE STUDY OF CHARGED MULTIPLICITY DISTRIBUTIONS. de Wolf, E.; Dumont, J. J.; Verbeure, F. (Institut Interuniversitaire des Sciences Nucleaires, Brussels (Belgium)). Nucl. Phys., B; 87: No. 2, 325-350(3 Mar 1975).

A compilation is made of charged multiplicity distributions for π^+, K^+, p and $\bar{p}$ interactions on hydrogen. Besides the usually studied parameters $\langle n_c \rangle$ and D, the skewness γ_1, the kurtosis γ_2 and the mode are closely examined. It is found that γ_1 and γ_2 may be considered as constant for $p_{lab} > 10$ GeV/c. As a consequence, all the data are well parametrized by means of the Edgeworth expansion, describing the approach to a Gaussian when the number of production centers is increased. The constancy of γ_1 would indicate that this number does not grow in the energy domain studied. Limited to the first order, the Edgeworth expansion is a useful alternative to the Czyzewski-Rybicki formula for expressing all the regularities of the multiplicity distributions. (auth)

Strong (Meson-induced)

Refer also to abstract 4567.

4568 (KFK-EXT-3/74-11) MEASUREMENT OF THE DETECTION EFFICIENCY OF A NEUTRON SPECTROMETER AND APPLICATION TO THE REACTIONS $\pi^-p \to \pi^0 n$ AND $\pi^-p \to \eta^0 n$. Stier, U. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Feb 1975. 89p. (In German). Dep. NTIS (US Sales Only) $7.50.

Thesis.

The charge-exchange reactions $\pi^-p \to \pi^0 n/| \to 2\gamma$ (1), and $\pi^-p \to \eta^0 n/| \to 2\gamma$ (2) are investigated in an experiment at 8 GeV/c incident pion momentum. The directions and energies of all participating particles are measured. The neutron could be determined by its time-of-flight and its interaction point in a large neutron spectrometer. Because of the energy dependence of the neutron detecting efficiency ϵ_n in plastic scintillators, the differential cross section of (1) and (2) are influenced by ϵ_n. In a special experiment $\epsilon_n = \epsilon(T_n)$ was determined with the reaction (1) at 660 MeV/c pion momentum. The differential cross sections of (1) and (2), corrected with ϵ_n, are compared with predictions of the Regge-pole model. (auth)

4569 (LBL-1060) STUDY OF THE REACTION pi/sup -/p YIELDS eta n IN THE REGION OF THE N*(1688). Chaffee, R. B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 25 Mar 1975. Contract W-7405-eng-48. 133p. Dep. NTIS $9.75.

Thesis.

In an experiment performed at the Bevatron, a negative-pion beam incident on a 20-cm liquid-hydrogen target produced reactions of the form pi/sup -/p yields neutral final state. The final-state neutron was detected by plastic-scintillator counters. The final-state photons were detected by lead-plate spark chambers, which covered about 3.7 pi solid angle, or by lead-scintillator sandwich counters, which covered most of the open face of the spark-chamber array. For this analysis, a kinematic fit was done on the L. B. L. computer for each event in which two photons were detected. For each momentum, events which fit the hypothesis pi/sup -/p yields eta n were binned according to the calculated production cosine, and the resulting distributions were corrected by comparing to the results of a Monte-Carlo calculation for the same reaction. The differential cross section was calculated for each bin, and the values for each momentum were fit to a sum of Legendre polynomials in production cosine. In the final chapter, the Legendre polynomial coefficients, the total cross section, and the differential cross sections extrapolated to 0^0 and 180^0 are compared to the results of other experiments, and some speculations are offered as to the spin-parity states which affect the measured behavior of the reaction. The conclusion is drawn that the N (1688) does not contribute, but that the N (1670) does, with a cross section of (0.84 +- 0.21) mb. (auth)

4570 (LNF-74/71(P)) MESON PRODUCTION BELOW 1 GeV FROM D-D INTERACTION. Banaigs, J.; Berger, J.; Cottereau, M.; Fabbri, F. L.; Goldzahl, L.; Le Brun, C.; Picozza, P.; Vu Hai, L. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 12 Dec 1974. 11p. (CONF-740984-4). Dep. NTIS (US Sales Only) $4.00.

From international conference on high energy collisions involving nuclei; Trieste, Italy (9 Sep 1974).

A study of the reaction $d + d \to {}^4He + mm^0$ was made at the Saclay Synchrotron Saturn at 1.9 to 3.8 GeV. The aim of the experiment was to test the charge symmetry for one π^0 missing mass, to bring in evidence the ABC effect, and finally to study isoscalar meson production. A bump was seen in the region of the ω^0. The momentum spectrum and differential cross sections are plotted. (JFP)

4571 (RL-75-014) K^-p ELASTIC SCATTERING BETWEEN 1094 MeV/c AND 1377 MeV/c. Barber, P. C.; Broome, T. A.; Duff, B. G. (Science Research Council, Chilton (UK). Rutherford Lab.). Jan 1975. 49p. (RPP/H-138). Dep. NTIS (US Sales Only) $5.50.

Differential cross sections for elastic scattering of negative kaons on protons are presented for 13 incident laboratory momenta between 1094 and 1377 MeV/c. The data show the characteristic forward diffraction-like peak and backward dip and are adequately described in shape by certain published partial wave analyses of the $\bar{K}N$ system. (auth)

4572 (TRI-74-1) CALCULATION OF THE SINGLE SCATTERING CONTRIBUTION TO THE DIFFERENTIAL CROSS-SECTION FOR THE ELASTIC SCATTERING OF 25- TO 100-MeV POSITIVE PIONS BY DEUTERIUM. McMillan, M.; Landau, R. H. (British Columbia Univ., Vancouver (Canada). TRIUMF Facility). Dec 1974. 35p. Dep. NTIS (US Sales Only) $4.75.

A numerical study of the single scattering contribution to the differential cross section for the elastic scattering of 25 to 100 MeV positive pions by deuterium was performed. In particular, effects due to the presence of the D-state component of the deuteron wave function, to internal motion of the target nucleons, and to uncertainties in the off-energy-shell pion-nucleon scattering amplitudes and the pion-nucleon phase shifts were examined. Results encourage further experimental and theoretical study of pion-nucleon and pion-deuteron scattering. They also encourage an experimental and theoretical study of $\pi^\pm - {}^3He$ elastic scattering as a means of investigating ^3He wave function components. (auth)

4573 TWO-PARTICLE CORRELATIONS IN 40 GeV π^-p INCLUSIVE REACTIONS AND PARTICLE PRODUCTION MECHANISMS. Grishin, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR); Sabeu, M.; Solomin, A. N. Yadern. Fiz.; 21: No. 2, 426-433(Feb 1975). (In Russian).

Inclusive two-particle correlations in rapidity variables between $\pi^+\pi^+$, $\pi^-\pi^-$ and $\pi^+\pi^-$ pairs obtained in 40 GeV π^-p collisions are discussed in the framework of the Mueller-Regge approach and the multiperipheral cluster model. The data show features similar to those obtained at much higher energies from the NAL and CERN-ISR. This behavior is easier understood in terms of the multiperipheral cluster model. Data on transverse momentum correlations in the same reactions may be qualitatively understood in the same model. (auth)

4574 MOMENTUM AND ANGULAR CHARACTERISTICS OF π^-p INTERACTIONS AT 40 GeV/c MOMENTUM. Alma-Ata-Budapest-Bucharest-Warsaw-Dubna-Krakov-Moscow-Safia-Tashkent-Tbilishi-Ulan-Bator-Hanoi Collaboration. Yadern. Fiz.; 21: No. 2, 328-338(Feb 1975). (In Russian).

Momentum and angular distributions of π^+, π^- mesons and γ quanta obtained by studying 2060 π^-p interaction events at 40 GeV/c are presented. The laboratory spectra of π^+ and π^- mesons are approximated by a sum of two and three exponentials. The momentum spectra in the C system were approximated by the Planc function. It is found that the Planc function does not describe the π^+ and π^- distributions in the C system. The distributions of pions in their own system, determined after excluding the leading particles in each event, as well are not described by the Planc function. The spectrum of the leading pions is obtained by subtracting the π^+ meson spectrum from the spectrum of π^- mesons. The mean number of leading pions is $\langle n_L \rangle = 0.25 \pm 0.05$. (auth)

4575 CHARGE EXCHANGE IN π^-p INTERACTIONS AT 40 GeV/c. Angelov, N.; Anela, L.; Bartke, E.; Ivanovskaya, I. A.; Kladnitskaya, E. N.; Mel'nikova, N. N.; Mikhul, A.; Fadeev, N. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 321-327(Feb 1975). (In Russian).

Multiple production of particles in π^-p interactions is studied in view of the charge exchange between the primary particle and the group of secondary particles emitted into the forward hemisphere in the c.m. frame. It is shown that the mean value of the exchanged

charge ΔQ is nonzero and equals to 0.490 ± 0.015. The largest contribution to the ΔQ distribution is from the events with $\Delta Q = 0$ and $\Delta Q = 1$ ($\approx 80\%$) indicating the dominating role of the multiperipheral processes. The distributions in $(\Delta Q - \langle \Delta Q \rangle)$ do not depend on type of the colliding particles and the energy in the interval 10 to 205 GeV/c. (auth)

4576 REACTION $\pi^- p \to \omega^0 n$ IN THE MOMENTUM RANGE FROM 20 TO 50 GeV/c. Bolotov, V. N.; Isakov, V. V.; Kakauridze, D. B.; Prokoshkin, Yu. D.; Sadovskii, S. A.; Khaustov, G. V. Yadern. Fiz.; 21: No. 2, 316-320(Feb 1975). (In Russian).

A peak corresponding to the decay $\omega^0 \to \pi^0\gamma$ in the reaction $\pi^- p \to \omega^0 n$ is found in the mass spectrum of 3γ states produced in $\pi^- p$ collisions. The measurements are made by means of the 70 GeV IHEP accelerator at 21, 25, 32.5, 40 and 48 GeV/c momenta. The reaction cross section decreases as momentum power ($\sim p^{-2,4}$) when the momentum increases. The differential cross section shows the exponential behavior exp (bt). The cone of the scattering narrows slowly when the energy decreases. (auth)

4577 INELASTIC $\pi^+ p$ INTERACTIONS AT THE ENERGIES OF 230 AND 275 MeV. Batusov, Yu. A.; Bunyatov, S. A.; Gulkanyan, G. R.; Sidorov, V. M.; Musakhanov, M.; Ionice, G.; Losnyanu, E.; Mihul, V.; Tuvdendorzh, D. (Joint Inst. for Nuclear Research, Dubna). Yadern. Fiz.; 21: No. 2, 308-315(Feb 1975). (In Russian).

The cross section of the reaction $\pi^+ p \to \pi^+\pi^+ n$ at the energy $T_\pi = 230$ MeV is measured with the result 30^{+18}_{-13} μbarn. The isotopic amplitudes of the reactions $\pi N \to \pi\pi N$ in the states P_{11} and P_{31} are determined at the threshold. In framework of the "soft-pion" theory the parameter of breaking of the chiral symmetry in the Lagrangian of processes $\pi\pi \to \pi\pi$ and $\pi N \to \pi\pi N$ near the threshold and the s-wave $\pi\pi$-scattering lengths are determined for states with isospin $T = 0$ and $T = 2$: $a_0 = 0.18 \pm 0.02$ m_π^{-1}, $a_2 = -0.07 \pm 0.01$ m_π^{-1}. Estimates are obtained for cross section of the reaction $\pi^+ p \to \pi^+\pi^0 p$ at enerties $T_\pi = 230$ MeV and $T_\pi = 275$ MeV and for cross section of the reaction $\pi^+ p \to \pi^+\pi^+ n$ at $T_\pi = 275$ MeV. Cross sections are determined for radiative π^+-meson scattering on proton ($E_\gamma > 50$ MeV) at the energies of 230 and 275 MeV. The work is carried out by means of the synchrocyclotron at LNP (JINR). (auth)

4578 CHARGED-PARTICLE MULTIPLICITY IN π^--NUCLEUS INTERACTIONS AT 100 AND 175 GeV/c. Busza, W.; Elias, J.E.; Jacobs, D.F.; Swartz, P.A.; Young, C.C. (Physics Department and Laboratory for Nuclear Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Sogard, M.R. Phys. Rev. Lett. 34: No. 13, 836-839 (31 Mar 1975).

The space-time evolution of particle production at high energies was investigated by measuring the charged multiplicity in π^--nucleus collisions at 100 and 175 GeV/c. We find that (a) the forward multiplicity (in the πp center-of-mass system) is independent of the target nucleus; (b) the backward multiplicity is approximately proportional to the nuclear thickness; and (c) the data are consistent with the assumption that the absorption cross section of the incident particle characterizes the multiplicity process. (auth)

4579 NEW MEASUREMENTS OF POLARIZATION AND DIFFERENTIAL CROSS SECTIONS IN K^+p ELASTIC SCATTERING IN THE 1.7—3-GeV/c RANGE. Patton, R.; Barletta, W.A.; Ehrlich, R.D.; Etkin, A.; Souder, P.A.; Zeller, M.E. (J. W. Gibbs Laboratory, Yale University, New Haven, Connecticut 06520); Mishina, M.; Lazarus, D.M. Phys. Rev. Lett. 34: No. 15, 975-978 (14 Apr 1975).

We have measured the polarization parameter and differential cross sections in K^+p elastic scattering from a polarized target from small $|t|$ and small $|u|$ at five momentum points; 1.7, 2.1, 2.4, 2.7, and 3.0 GeV/c. The polarized-proton target was butanol cooled at 0.5° by a ^{3}He–^{4}He refrigerator; a combination of multiwire proportional chambers and scintillation counters detected the scattered particles. The results for small $|u|$ are discussed in the context of pure Regge-pole models with exchange-degenerate A trajectories. (auth)

4580 HYPERNUCLEAR SPECTROSCOPY: A NEW TREND IN HYPERNUCLEAR PHYSICS. Pniewski, J.; Zakrzewski, J. (Univ., Warsaw). Nukleonika; 20: No. 1, 43-53(1975).

This is a short review article on the progress in the study of hypernuclear physics and on the perspectives of hypernuclear spectroscopy. It treats the following subjects: experimentally observed excited states of the hypernuclei $^{4}_{\Lambda}H^*$ and $^{4}_{\Lambda}He^*$–gamma-decaying states, $^{12}_{\Lambda}C^*$–resonant state decaying with the emission of a proton, $^{7}_{\Lambda}He^*$–long-lived hyperisomer; first results of gamma spectroscopy done with counter technique; pion spectroscopy experiments initiated with nuclear emulsions and continued with the counter technique; general remarks on the excited states of hypernuclei and information concerning the ΛN interaction. (6 figures) (auth)

4581 ANGULAR DISTRIBUTIONS OF SECONDARY PIONS IN THE REACTION $\pi^- p \to \pi^-\pi^+ n$. Kartamyshev, A.A.; Mikhin, K.N.; Romantseva, A.S.; Patarakin, O.O.; Sulkovskaya, M.M.; Sustavov, A.F.; Surkova, L.V.; Chernysheva, L.A. JETP Lett. 20: No. 11, 346-348 (5 Dec 1974).

Results are presented of the analysis of the angular distributions of the secondary pions in the reaction $\pi^- p \to \pi^-\pi^+ n$. The asymmetry of the angular distributions in the region of the ρ^0 resonance is confirmed and the angular symmetry function R is calculated. Using the spin density matrix formalism, the experimental data are compared with the predictions of the one–pion exchange (OPE), one–pion exchange with form factor (OPEF), and the absorption (OPEA) models. Good agreement with experiment is obtained with the OPEA model. (auth)

4582 $K^*(890)$ PRODUCTION IN $NK\pi\pi$ FINAL STATES AT 10 GeV/c. Graessler, H.; Laven, H.; Schulte, R. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.); Becker, L.; Klabuhn, J.; Lohmann, W.; Matthaues, E.; Schreiber, H. J.; Weigt, G. (SEE CODE-7041274 Deutsche Akademie der Wissenschaften zu Berlin (German Democratic Republic)); Kuhn, D. Nucl. Phys., B; 88: No. 1, 1-17(17 Mar 1975).

Results are presented for reactions of the type $K^- p \to K^*(890)(N\pi)$ at 10 GeV/c, where the $K^*(890)$ resonance is produced in association with a nucleon pion system. It is found that: Of the five measurable density matrix elements, only two are nonzero. In particular, the imaginary parts representing interference terms between opposite parity exchanges are consistently zero. In the noncharge exchange channels, $K^- p \to K^{*-}(N\pi)^+$, natural and unnatural spin-parity exchanges are equal. In the charge exchange $K^{*0}(890)(p\pi^-)$ channel, unnatural spin-parity exchange dominates. The differential cross sections, $d\sigma/dt'$, are steeper for unnatural spin-parity exchange than for natural spin-parity exchange. A t-channel isospin separation reveals that isovector exchange to $I(N\pi) = 3/2$ is dominant and that for $I(N\pi) = 1/2$, $I = 0$ exchange is stronger than $I = 1$ exchange. Combining the t-channel isospin decomposition with the separation of definite spin-parity exchange, the isovector exchange is found to contain about 50% natural and 50% unnatural spin-parity components. (auth)

4583 PRODUCTION OF A LOW-MASS $d\pi^+\pi^-$ ENHANCEMENT. Bingham, H. H.; Fretter, W. B.; Graves, W. R.; Porter, F. C.; Stutte, L.; Yost, G. P. (California Univ., Berkeley (USA). Dept. of Physics); Dunn, L. A.; Harris, R.; Lubatti, H. J.; Moriyasu, K. Nucl. Phys., B; 88: No. 2, 275-284(24 Mar 1975).

A broad threshold $d\pi^+\pi^-$ enhancement was observed in $\pi^- d \to d\pi^+\pi^-\pi^-$ at 15 GeV/c. It can be described by a model which assumes terms involving intermediate N^*_δ production, plus a Deck type enhancement. A simple calculation based on $\pi^\pm p$ data is successful in reproducing the main features of the data. (auth)

4584 INCLUSIVE K^0, $K^{*+}(892)$ AND $\pi^\pm$ PRODUCTION IN K^+p INTERACTIONS AT 8.2 AND 16 GeV/c AND QUARK MODELS IN THE CENTRAL AND FRAGMENTATION REGIONS. Chliapnikov, P. V.; Gerdyukov, L. N.; Gorbunov, P. A.; Uvarov, U. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij); Grard, F.; Henri, V. P.; Herquet, P.; Windmolders, R. (Centre Universitaire de l'Etat a Mons (Belgium)); Verbeure, F. (Brussels Univ. (Belgium)); Ciapetti, G. Nucl. Phys., B; 88: No. 2, 189-201 (24 Mar 1975).

Results are presented on the production of K^0, $K^{*+}(892)$ and $\pi^\pm$ in the reaction $K^+p \to K^0 + \pi^\pm +$ anything at 8.2 and 16 GeV/c. The $\pi^\pm$ forward and backward $d\sigma/dx$ distributions are of the form $\exp(-Ax)$. It is shown that the forward and backward values of A in a quark–quark rest frame change after subtraction of the contributions due to the resonances produced. A comparison is made of $d\sigma/dx$ inclusive cross sections for K^0's and $K^{*+}(892)$ with the predictions of a quark model in the fragmentation region. The experimental cross section matches the theoretical predictions for K^0's but disagree with those for $K^{*+}(892)$. (auth)

4585 THE INCLUSIVE REACTIONS $\pi^+ d \to \pi^-$ + ANYTHING AND $\pi^+ d \to \pi^-\pi^-$ + ANYTHING AT 6 AND 24 GeV/c. Sreedhar, V. (Johns Hopkins Univ., Baltimore, Md. (USA)); Fickinger, W.; Robinson, D. W. (Case Western Reserve Univ., Cleveland, Ohio (USA)); Bromberg, C.; Ferbel, T.; Slattery, P. (Rochester Univ., N. Y. (USA)); Engler, A.; Kraemer, R. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Nucl. Phys., B; 88: No. 2, 202-214 (24 Mar 1975).

Inclusive production of π^- mesons was studied with 6 and 24 GeV/c π^+ beams interacting in deuterium bubble chambers. The energy dependence of the inclusive spectra is discussed. In comparison with π^+p inclusive interactions, it is observed that projectile fragmentation is not independant of the nature of the target at 6 GeV/c. Cross sections and ratios of cross sections

are presented. Two-particle correlations are found to be similar at both energies. (auth)

4586 THE ROLE OF TWO-STEP CONTRIBUTIONS IN NUCLEAR COHERENT AND INCOHERENT PION PRODUCTION. Faeldt, G. (Lund Univ. (Sweden). Institutionen foer Teoretisk Fysik med Mekanik); Osland, P. (Trondheim Univ. (Norway). Institutt for Fysikk). Nucl. Phys., B; 87: No. 3, 445-460(10 Mar 1975).

The recent CERN measurements of 3π and 5π production on nuclear targets are analyzed in terms of one- and two-step production. It is argued that the value of the 5π nucleon total cross section is an effect which can be ascribed to interference between one- and two-step terms. For the A_3 case the evidence for two-step contributions is at present rather weak. (auth)

4587 STUDY OF THE $K^+\pi^-$ TOTAL CROSS SECTION FOR c.m. ENERGY UP TO 3.4 GeV. Chliapnikov, P. V.; Gerdyukov, L. N.; Tchikilev, O. G.; Vorobjev, A. P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij); Ciapetti, G.; Dunwoodie, W.; Goldschmidt-Clermont, Y.; Grant, A.; Sekera, Z.; Stergiou, A. Phys. Lett., B; 55: No. 2, 237-240(3 Feb 1975).

The reaction $K^+p \rightarrow \Delta^{++}(1236) +$ anything is studied at a beam momentum of 16.0 GeV/c. The total and topological cross sections for $K^+\pi^-$ interactions are estimated by a Chew-Low extrapolation from threshold to the c.m. energy of 3.4 GeV by the maximum likelihood method. (auth)

4588 A STUDY OF HIGH TRANSVERSE MOMENTUM η AND π^0 MESONS AT THE CERN ISR. Buesser, F. W.; Camilleri, L.; Di Lella, L.; Pope, B. G.; Smith, A. M. (European Organization for Nuclear Research, Geneva (Switzerland)); Blumenfeld, B. J.; White, S. N. (Columbia Univ., New York (USA)); Rothenberg, A. F.; Segler, S. L.; Tannenbaum, M. J. (Rockefeller Univ., New York (USA)). Phys. Lett., B; 55: No. 2, 232-236 (3 Feb 1975).

The production of high transverse momentum η mesons from proton-proton collisions was studied at the CERN ISR. The decay $\eta \rightarrow \gamma\gamma$ was identified in an array of lead-glass Cerenkov counters. The preliminary results obtained at a total center-of-mass energy $\sqrt{s} = 52.7$ GeV, show an η signal which amounts to approximately one half of the π^0 cross section for center-of-mass transverse momenta between 3 and 5 GeV/c. The production of high transverse momentum π^0s was also measured and compared with previous results. (auth)

4589 K^+p INTERACTIONS NEAR 3 GeV/c. II. Baryon Resonance Production. Musgrave, B.; Peeters, P.; Schreiner, P.; Whitmore, J.; Yuta, H. (Argonne National Lab., Ill. (USA)). Nucl. Phys., B; 87: No. 3, 365-398(10 Mar 1975).

Baryon resonance production in quasi-two body reactions were studied for the channels $K^+p \rightarrow K^0p\pi^+$, $K^+n\pi^+$ and $K^+p\pi^0$ at beam momenta of 2.53, 2.76 and 3.20 GeV/c. The production cross sections, four-momentum transfer distributions and density matrix elements are given for the $\Delta(1236)$, $N^*(1400)$, $N^*(1500)$ and $N^*(1680)$ states. The reaction $K^+p \rightarrow K^0\Delta^{++}(1236)$ is compared to the line reversed reaction $K^-n \rightarrow \bar{K}^0\Delta^-$ and the charge-exchange SU(3) sum rule for pseudoscalar meson plus $\Delta(1236)$ is tested. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 4366, 4533, 4534, 4537, 4792, and 5120.

4590 (CERN-75-2) POWER LAWS IN PARTICLE PHYSICS. Amati, D.; Fubini, S. (European Organization for Nuclear Research, Geneva (Switzerland)). 11 Mar 1975. 37p. Dep NTIS (US Sales Only) $5.00.

These lecture notes present a theoretical survey of the different scaling asymptotic behaviors found in experimental data, and their connection with the underlying hadron dynamics. As an initial classification of the phenomena, purely hadronic processes, and processes including weak or electromagnetic interactions, are considered, both in inclusive and exclusive reactions. The transition between different power laws is investigated. The main properties of the different scaling behaviors are treated, in the light of the parton and the multiperipheral models. Finally the presence of logarithmic asymptotic behaviors and the dynamical origin of scales are discussed. (auth)

4591 (COO-1545-152) SPONTANEOUSLY BROKEN ABELIAN GAUGE INVARIANT SUPERSYMMETRIC MODEL. Mainland, G. B.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics). [nd]. Contract AT(11-1)-1545. 12p. Dep. NTIS $4.00.

A model is presented that is invariant under an Abelian gauge transformation and a modified supersymmetry transformation. This model is broken spontaneously, and the interplay between symmetry breaking, Goldstone particles, and mass breaking is studied. In the present model, spontaneously breaking the Abelian symmetry of the vacuum restores the invariance of the vacuum under a modified supersymmetry transformation. (auth)

4592 (JINR-E1-8654) CHARGE TRANSFER IN HIGH-ENERGY INTERACTIONS. Mihul, A.; Angelescu, T. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

Available experimental data about charge transfer were gathered and compared with some theoretical predictions. The investigation has been performed at the Laboratory of High Energies, JINR. (auth)

4593 (JINR-E1-8657) PROBLEM OF PROVING THE EXISTENCE OF "CHARMED" PARTICLES. Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

In order to search for "charmed" particles a possibility of performing an experiment is discussed in which one could observe a new particle and prove a necessity of introducing for this particle a new quantum number conserved in strong interactions. (auth)

4594 (JINR-E2-8530) POSSIBLE VIOLATION OF CP-INVARIANCE IN THE DECAYS OF CHARMED PARTICLES. Okun, L. B.; Pontecorvo, B. M.; Zakharov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 9p. Dep. NTIS (US Sales Only) $4.00.

The possibility is considered that CP-invariance is violated in charmed particle decays. The study of the $D^0 - \bar{D}^0$ system, which would be produced in e^+e^- collisions, is suggested for the investigation of CP violating effects. (auth)

4595 (JINR-P2-8670) CORRELATION FEATURES OF ASSOCIATED MULTIPLICITY AND AUTOMODEL BEHAVIOR OF SEMI-INCLUSIVE CROSS SECTIONS. Matveev, V. A.; Sisakyan, A. N.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Based on the coherent nature of hadron excitations in high energy collisions and the automodelity principle in semi-inclusive reactions the average multiplicity rise with transverse momenta is considered. Scaling type behavior of semi-inclusive cross sections is predicted. (auth)

4596 (RL-75-025) PHENOMENOLOGICAL TESTS OF f-DOMINATED POMERON IN INCLUSIVE REACTIONS. Inami, T.; Roberts, R. G. (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 33p. (T-107). Dep. NTIS (US Sales Only) $4.75.

Results of an analysis of data on several inclusive processes which test the hypothesis of f-dominance of the Pomeron (F.D.P.). Both nondiffractive and diffractive reactions are studied. In the first case a comparison of pairs of fragmentation processes (one exotic, the other nonexotic) are considered so that the Pomeron and f-exchange contributions can be estimated and their ratio compared with that obtained from total cross sections. It is found that the f: P ratio is largely independent of both t and M^2/s, and its value is consistent with that given by total cross sections, thus giving strong support to the F.D.P. hypothesis. For the diffractive inclusive process, the hypothesis relates all the couplings PPP, PPM, MMP, MMM and the interference term PMP to one overall coupling. A triple-Regge analysis of the world data is carried out on $pp \rightarrow pX$ using the F.D.P. couplings together with π-exchange contributions which are consistent with the $pn \rightarrow pX$ data. Good agreement is obtained with the data and with conventional triple-Regge fits (which have no constraints on the couplings) except for small t. The data at small t, including the $pd \rightarrow dX$ data, almost scale with energy and require a substantially smaller value of PPM/PPP than that according to the F.D.P. hypothesis. On the whole, however, it is felt that the predictions of F.D.P. for inclusive reactions are experimentally well satisfied for a wide class of data. (auth)

4597 (RL-75-030) IS THE ABSENCE OF SEMI-INCLUSIVE CORRELATIONS COMPATIBLE WITH THE CLUSTER MODEL.

Gula, A. (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 12p. (T-108). Dep. NTIS (US Sales Only) $4.00.

It is shown that in a realistic cluster model the positive short-range correlations between particles coming from the same cluster tend to be cancelled by negative correlations between the clusters themselves. The no-correlation pattern of semi-inclusive data (which seemed to disfavor the otherwise successful cluster model) is well reproduced. (auth)

4598 RAPIDITY CORRELATIONS IN THE MULTIPERIPHERAL APPROACH WITH BRANCH POINTS. Levin, E. M.; Ryskin, M. G. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 21: No. 2, 396-412(Feb 1975). (In Russian).

It is shown that in any multiperipheral model two-particle rapidity correlations in a separate multiperipheral chain are negative for small differences of rapidities, which fact is due to the threshold behavior of the interaction cross section of neighboring hadrons at low energies; large positive correlations at present day energies ($s = 400$ to $3000\ GeV^2$) arise due to the emission of particles by several multiperipheral chains (or branch points in the complex momenta language). E.g., nonenhanced branch points give a positive and rapidity independent correlation $R(y_1, y_2) = 0.35$. Besides, one discusses the contribution from enhanced pomeron and nonpomeron branch points to two-particle correlations; the effect of the isotopic structure of the multiperipheral chain on the correlation between $\pi^+\pi^-$ and $\pi^-\pi^-$ mesons and the correlation in quasi-inclusive processes, where the multiplicity of charged particles is fixed. (auth)

4599 INCLUSIVE SPECTRA AND STRUCTURE OF THE MULTIPERIPHERAL CHAIN. Gendenshtein, L. E. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 21: No. 2, 386-395(Feb 1975). (In Russian).

Display of structure of the multiperipheral chain in the inclusive spectra is considered. A generalization of the Mueller–Kancheli method to determine the inclusive spectra is presented that takes into account the effect of clusterization along the multiperipheral chain and different densities of the rapidity distributions of the detected particles in various clusters. Examples of the inclusive spectra and approach to the scaling behavior in the central region are considered. (auth)

4600 HIGH ENERGY ASTROPHYSICS AND ITS RELATION TO ELEMENTARY PARTICLE PHYSICS. Conference Held at Erice, Italy, June 16–July 6, 1972. Brecher, K.; Setti, G. (eds.). Cambridge, MA; Massachusetts Institute of Technology Press (1974). 596p. (CONF-7206108-; ISBN-0-262-02115-3; ISBN-0-262-52035-4). $9.95.

Separate abstracts were prepared for the 13 lectures presented. (JFP)

For abstracts of individual lectures see: 4192, 4193, 4206, 4207, 4329, 4330, 4362–4366, 4674, and 5290.

4601 SYMMETRY CONSTRAINTS ON INCLUSIVE REACTIONS IN THE FRAGMENTATION REGION. Leroy, C.; van Parijs, J. (Univ., Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. I; 89: No. 1, 63-68(1975).

Mueller's theorem, supplemented by factorization and SU(3) symmetry at the vertices $\pi\pi$ and $K\bar{K}$, is used to study the target fragmentation region of the inclusive reactions $a + b \to \pi + X$, $a + b \to \pi + \pi + X$. Relations among the inclusive cross sections of $\pi + b \to c + X$ and $K + b \to c + X$ and of $\pi + b \to \pi + \pi + X$ and $K + b \to \pi + \pi + X$ are derived ($b = p$, n or d). (auth)

4602 SCALING LAWS FOR INELASTIC PARTIAL-WAVE AMPLITUDES AND THE HIGH-ENERGY BEHAVIOUR OF MULTIPARTICLE PRODUCTION. Haan, O.; Muetter, K. H. (Heidelberg Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Nucl. Phys., B; 88: No. 1, 171-188(17 Mar 1975).

The t-channel unitarity equations are derived for n-particle overlap functions. Together with s-channel unitarity they lead to scaling laws for the inelastic s-channel partial-wave amplitudes $f_l^{(n)}(s)$ in the limit $s \to \infty$, $l \to \infty$ $\chi = l(\mu/\sqrt{s})^3 =$ fixed. Assuming the validity of the scaling law in the whole range, allowed by s-channel unitarity–i.e., for $1 > L(s) = (\alpha(4\mu^2) - 1)(\sqrt{s}/4\mu)$ log (s/s_1) constant production cross sections $\sigma^{(n)}(s)$ at high energies $s \to \infty$ up to log s factors are obtained. (auth)

4603 FINAL-STATE ABSORPTION IN MULTIPERIPHERAL MODELS. Ciafaloni, M.; Marchesini, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Phys., B; 88: No. 1, 109-135(17 Mar 1975).

S-channel unitarity effects in multiperipheral production amplitudes due to final state particle rescattering are studied. For nondiffractive events it is shown that–if the pomeron is required to have $\alpha(0) = 1$–the absorbed overlap function leads to $\sigma_{in} \sim (\ln s)^{\eta}$ and forward peak shrinking as $(\ln s)^{\nu}$ similarly to Reggeon field theories. Inclusive many-particle distributions and production cross sections are calculated, and found to have logarithmic multiplicity and integrable, i.e., not very long-range, correlations in the inelastic component. The t-distribution for diffractive production of large masses is found to have no turnover at small t in the model, but the probability of large-gap events is damped by absorption, so that consistency with unitarity is achieved. By the same token the Finkelstein–Kajantie paradox is avoided and multiple diffractive events give at most a small intercept renormalization. A comparison of this s-channel point of view with reggeon field theory is also given. (auth)

4604 INCOHERENCE AND CLUSTER EMISSION. Redei, L. B. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Phys., B; 88: No. 1, 136-144(17 Mar 1975).

It is shown that the generating function of the independent cluster emission model can be derived from the assumption that the number of modes in which the secondaries are produced is very large. A mechanism for the suppression of the quantum mechanical interference corrections to the classical cluster emission model is discussed. (auth)

4605 FROM MATHEMATICS TO PHENOMENOLOGICAL PARTICLE PHYSICS. van Hove, L. (European Organization for Nuclear Research, Geneva (Switzerland)). pp 19-23 of Physics: Basis of Technology. Plenary Lectures. Weinheim, F. R. Germany; Physik Verl. (1974).

From 38th meeting of physicists'; Nuernberg, F. R. Germany (23 Sep 1974). 3 refs.

The variety of ways is illustrated in which mathematical methods, concepts and results find applications in physics. The first example concerns vibrations of a periodic crystal lattice and conduction electrons in a static periodic lattice. The second example concerns recent work on the internal structure of the nucleon and its manifestation in various types of high-energy collisions. (GE)

4606 ASYMPTOTIC BEHAVIOR FROM THE EXACT CALLAN–SYMANZIK EQUATIONS. Meyer, P.; Sourlas, N. (Ecole Normale Superieure, 75 - Paris (France). Lab. de Physique). Nucl. Phys., B; 87: No. 2, 238-254(3 Mar 1975).

The exact Callan-Symanzik equations written in the functional formalism are solved without dropping the mass-insertion terms. From the exact solution, the asymptotic behavior of Green functions at nonexceptional momenta is found without referring to Weinberg's power-counting theorem. In the case of asymptotically free theories, the nonleading asymptotic terms are also computed without using Wilson's operator product expansion. Finally, the case of exceptional momenta is discussed, and the asymptotics of theories with broken symmetry studied. (auth)

4607 TRANSFORMATION PROPERTIES OF THE SUPERCURRENT. Ferrara, S.; Zumino, B. (European Organization for Nuclear Research, Geneva (Switzerland)). Nucl. Phys., B; 87: No. 2, 207-220(3 Mar 1975).

It is shown that the spinor current, if correctly defined, belongs to a supermultiplet, together with the energy-momentum tensor and the axial-vector current. The transformation properties of this supermultiplet under both restricted and general supersymmetry transformations are given. The generators of special supersymmetry transformations can be obtained as first moments of the time component of the spinor current. The transformation laws of the supermultiplet containing the spinor current provide the local version of the supersymmetry algebra. (auth)

4608 THE IMPACT PARAMETER STRUCTURE OF MULTIPARTICLE PRODUCTION. Webber, B. R. (Cambridge Univ. (UK). Cavendish Lab.). Nucl. Phys., B; 87: No. 2, 269-317 (3 Mar 1975).

High energy exclusive and inclusive cross sections are discussed in terms of their dependence on the transverse-position variables (impact parameters) of incident and outgoing particles. The objective is to clarify the points of conflict and agreement of various models with each other and with intuitive ideas based on macroscopic collisions. First the impact parameter representation of states and amplitudes is reviewed. New impact parameter conservation laws and sum rules are derived from Lorentz invariance. The generalized optical theorem of Mueller is extended to give the impact parameter distribution of produced particles. Mueller-Regge behavior is shown to imply three-dimensional limiting fragmentation in (impact parameter, rapidity)- space and a specific linear structure of the final-state particle density in the central region of this space. The predictions of weak- and strong-coupling multiperipheral models, the ϕ^3 ladder eikonal model, and the dual resonance model are presented, with emphasis on the dependence of average multiplicity on impact parameter

and the dependence of mean square impact parameter on multiplicity. Special techniques for strong-coupling multiperipheral models are used to study the breakdown of the random-walk impact-parameter structure of the weak-coupling case, and to show explicitly that the average multiplicity is a decreasing function of impact parameter in the strongly coupled ABFST model. (auth)

Electromagnetic

Refer also to abstracts 4364, 5208, and 5283.

4609 (CEA-N-1700, pp 198-199) π^+ ELECTROPRODUCTION WITH PROTONS. Duclos, J.; Julien, J.; Magnon, A.; Michel, B.; Montret, J. C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

An experiment aimed at measuring the positive pion charge radius has been prepared. The cross section of the reaction $e^-p \rightarrow e^-n\pi^+$ will be measured for q^2 values of the exchanged photon ranging from 1 fm^{-2} to 3 fm^{-2} and at 1175 MeV for the invariant mass of the pion-nucleon system. The feasibility of such a measurement has been studied in a preliminary run where single rates in both the scattered electron and pion channels were measured. (auth)

4610 (DESY-75/04) ELECTROMAGNETIC FORM FACTORS OF N* RESONANCES AND THEIR DETERMINATION FROM PION ELECTROPRODUCTION. Devenish, R. C. E.; Lyth, D. H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Jan 1975. 54p. Dep. NTIS (US Sales Only) $5.75.

It is shown how N* electromagnetic form factors can be parametrized in a simple way to take account of their known behavior at threshold. Using such form factors and Breit-Wigners to represent the final state interaction, the imaginary parts of the invariant amplitudes are calculated for the process $eN \rightarrow eN\pi$ the real parts are calculated from fixed t dispersion relations. The complete amplitudes are then fit to the coincidence data in the resonance region ($0 < |\lambda^2| < 1.0$ GeV^2; $w < 2$ GeV) in order to determine the form factor parameters. Results are presented for the λ^2 dependence of the resonant multipoles and in particular stable results are found for the $P_{11}(1434)$, $S_{11}(1505)$, $D_{13}(1520)$, $F_{15}(1688)$ and $F_{37}(1940)$. A critical discussion is given of the effect of theoretical uncertainties on the results. Results are used to calculate the helicity asymmetry A on the resonant peaks seen in eN scattering, and it is found that on the 2nd and 3rd peaks A changes sign in the vicinity of $\lambda^2 = -1$. GeV^2. (auth)

4611 (IPNO-PhN-75-01) COHERENT π^+ PHOTOPRODUCTION ON ^{3}He IN THE (3,3) RESONANCE REGION. Bachelier, D.; Bernas, M.; Boyard, J. L.; Jourdain, J. C.; Radvanyi, P. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1975. 29p. Dep. NTIS (US Sales Only) $4.50.

Thesis.

An experimental study of the $^3He(\gamma,\pi^+)$ ^3H reaction was performed in the (3,3) resonance region between 227 and 453 MeV. The experiment shows two main features; at fixed four-momentum transfer q^2, the resonance is shifted towards lower energies, this shift increasing with q^2; at a fixed angle, but variable q^2, the minimum of the charge form factor observed in the elastic scattering of electrons on ^{3}He does not appear. Recent calculations explain partly these two effects. (auth)

4612 (ITF-74-144P) INCLUSIVE PROPERTIES OF HIGH-ENERGY e^+e^- ANNIHILATION IN HADRONS IN DUAL RESONANCE MODEL. Makarov, V. I. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The inclusive spectrum and multiplicity of finite products of the electron-positron annihilation in hadrons are investigated in the framework of statistical approach to the dual resonance models. (auth)

4613 (JINR-E2-8572) QUARKS, PARTONS, AND A POSSIBLE GLOBAL BOOTSTRAP. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

The values of the charges of various vector fields (electric charge e, specific charges of ρ, ϕ and ω meson fields g_ρ, g_ϕ and g_ω)as well as the values of the gravitational constant κ, the Planck constant $\hbar$ and the light velocity constant c can be used to construct a number of quantities of masses near $10^{-5} - 10^{-6}$ gr, $(e/\sqrt{\kappa}) \sim 10^{-6}$ gr, $(g/\sqrt{\kappa}) \sim 10^{-5}$ gr, $\sqrt{\hbar c}/\kappa \sim 10^{-5}$ gr. Within the framework of general relativity the appropriate particles ("maximons") are naturally interpreted as elementary as black holes of dimensions $r_0 \sim 10^{-32}$-10^{-33}cm, or as objects with internal static metric described by the Papapetrou model. In the hadron models admitting arbitrary heavy quarks account should be taken of a possible existence of particles (stable or unstable) like maximons. The quantum aspect of maximon theory is discussed. (auth)

4614 (JINR-P2-8454) POSSIBLE DETERMINATION OF THE PARTON MASS SPECTRUM OVER THE TOTAL $e^+e^- \rightarrow$ HADRON ANNIHILATION CROSS SECTION. Vashakidze, Sh. I.; Matveev, V. A.; Tolkachev, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The problem of the parton mass spectrum determination over the known total cross section for the $e^+e^- \rightarrow$ hadron annihilation is considered. Using the generalized function theory theorems one gives an accurate solution of this problem without restriction to the total cross section for the parton spins 0 and ½. (auth)

4615 (UCRL-Trans-10838) BREMSSTRAHLUNG ASSOCIATED WITH THE COLLISION OF ELECTRONS. Lifshits, E. M. Translated from Zh. Eksp. Teor. Fiz.; 18: No. 6, 562-565(Mar 1975). 7p. Dep. NTIS $4.00.

A relatively simple calculation of the bremsstrahlung associated with the collision of electrons is possible in the nonrelativistic case when the collision velocity is so great that the classical formula is inapplicable yet is still small compared to the speed of light. It is assumed that $\alpha \ll e^2/\hbar v \ll 1$, where $\alpha = e^2/\hbar c$ for the given treatment. The final formula obtained for the angular distribution of the total radiation is indicated. (JFP)

4616 TRANSITION RADIATION AND ITS APPLICATIONS. Michalak, S. (Univ., Lodz, Poland). Postepy Fiz.; 25: No. 6, 677-685(1974). (In Polish).

The paper presents the state of studies on the transition radiation and its applications with special considerations of relativistic optical and x-ray transition radiation. (auth)

4617 POSSIBILITY TO STUDY THE SCATTERING OF LIGHT BY LIGHT IN e^+e^- COLLIDING BEAMS. Baier, V. N.; Kuraev, E. A.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 21: No. 2, 339-346(Feb 1975). (In Russian).

The possibility of experimentally studying the scattering of light by light in e^+e^- colliding beams is shown for experiments with detection of photons having the energy $\gtrsim m$ and forming large angles with respect to the collision line of initial particles. The main background processes are estimated: the double bremsstrahlung at large angles and the emission of two photons in e^+e^- pair electroproduction. (auth)

4618 GENERATION OF A SUPER-NARROW LINE OF THE MAGNETIC RESONANCE ON THE ULTRA-COLD NEUTRONS IN ORDER TO MEASURE THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Egorov, A. I.; Ezhov, V. F.; Ivanov, S. N.; Knyaz'kov, V. A.; Lobashev, V. M.; Nazarenko, V. A.; Porsev, G. D.; Serebrov, A. P. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 21: No. 2, 292-299(Feb 1975). (In Russian).

Experimental results are given on the generation of super-narrow curves of the magnetic resonance with the half-width $\Delta\nu = 0.2$ to 0.3 Hz, corresponding to $\Delta E \approx 10^{-15}$ eV. A description is presented of a set-up for the determination of the electric dipole moment of the neutron, during which the resonances were obtained. (auth)

4619 PAIR PRODUCTION AND BREMSSTRAHLUNG OF CHARGED LEPTONS. Tsai, Y. (Stanford Linear Accelerator Centers, Stanford University, Stanford, California 94305). Rev. Mod. Phys. 46: No. 4, 815-851 (Oct 1974).

Photo pair productions of electrons, muons, and heavy leptons and bremsstrahlung of electrons and muons are reviewed. Atomic and nuclear form factors necessary for these calculations are discussed. Straggling of electrons in matter and other effects due to finite target thickness are considered. Tables of radiation lengths of all materials and the energy dependence of photon absorption coefficients of many materials are presented. Problems associated with production of particles by photon and electron beams are also discussed. (auth)

4620 π^0–MESON POLE IN γP SCATTERING AND PROTON POLARIZABILITY. Baranov, P.S.; Fil'kov, L.V.; Shtarkov, L.N. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). JETP Lett. 20: No. 11, 353-354 (5 Dec 1974).

It is shown that allowance for the π^0–meson pole is essential when the proton polarizability is determined from experiments on γp scattering. The sign of the π^0–2γ decay amplitude is obtained from experiments on γp scattering in the range 80–110 MeV, namely $g_{\pi NN}F_\pi < 0$. (auth)

4621 DELBRUECK SCATTERING CALCULATIONS. Papatzacos, P.; Mork, K. Ark. Fys. Seminar Trondheim; No. 1, 44p(1975).

The cross section for elastic scattering of photons on a static

Coulomb potential, Delbrück scattering, is calculated in the lowest order Born approximation. Using conventional Feynman techniques and gauge invariance, expressions are obtained for the real and imaginary parts of the scattering amplitude for polarized photons. These rather complicated expressions contain multidimensional integrals which were evaluated partly by analytical and partly by numerical methods, and Delbrück amplitudes were obtained for various scattering angles and for photon energies ω varying from zero and up to several GeV. The results confirm earlier calculations at very low energies ($\omega \ll 1$ MeV), confirm the imaginary parts but disagree with the real parts previously obtained by Ehlotzky and Sheppey for $\omega < 20$ MeV, and confirm the high energy results of Cheng and Wu to lowest order. A comparison with some recent experiments is shown. (auth)

4622 PION POLARIZABILITY IN CHIRAL QUANTUM FIELD THEORY. Pervushin, V. N.; Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). Phys. Lett., B; 55: No. 4, 405-408(3 Mar 1975).

The amplitude for the process $\gamma\gamma \to \pi\pi$ is calculated in the chiral quantum field theory. The values $\alpha_\pi(\pm) = 0.3\ \alpha/m_\pi^3$ and $\alpha_\pi(0) = -0.04\ \alpha/m_\pi^3$ are found for the pion polarizabilities. (auth)

4623 THE GREEN FUNCTION OF THE STATIONARY SCHROEDINGER EQUATION FOR A PARTICLE IN A UNIFORM MAGNETIC FIELD. Dodonov, V. V.; Malkin, I. A.; Man'ko, V. I. (P. N. Lebedev Institute of Physics, Moscow, USSR). Phys. Lett., A; 51: No. 3, 133-134(24 Feb 1975).

The explicit expression for the Green function of the stationary two-dimensional Schroedinger equation for a particle in a uniform magnetic field is obtained in terms of the Whittaker function. (auth)

4624 BARRIER PENETRATION AS MODEL FOR TACHYONS. Strnad, J.; Kodre, A. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Phys. Lett., A; 51: No. 3, 139-140(24 Feb 1975).

Transmission of electromagnetic waves across an optically less-dense layer is proposed as a model for tachyons. Supercritical and subcritical incidence corresponds to tachyonic and bradyonic signals, respectively. (auth)

4625 PARTONS WITH INTEGRAL CHARGES. Kuehnelt, H. (Vienna Univ. (Austria). Inst. fuer Theoretische Physik); Nachtmann, O. (Bern Univ. (Switzerland). Inst. fuer Theoretische Physik). Nucl. Phys., B; 88: No. 1, 41-51(17 Mar 1975).

Parton models with integrally charged partons are examined. It is found that models where partons carry the quantum numbers of SU(3) singlets and octets are equally as compatible with experimental data on deep inelastic lepton nucleon scattering as the usual quark parton model. Some remarks on the constant S of $\pi^0 \to 2\gamma$ decay and the asymptotic value R of the ratio $\sigma(e^+e^- \to \text{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)$ are made. It is found that the "simplest" parton model with integrally charged partons being compatible with data on deep inelastic lepton nucleon scattering and giving $S = \frac{1}{2}$ requires singlet, octet and decimet partons and predicts $R = 22$! The models considered may seem unaesthetic, but it is probably worthwhile to know that they are not excluded by experiment. In fact they suggest that partons may be bare quanta of the usual baryons. (auth)

4626 ON THE ELECTRON-MUON MASS RATIO. Dillenburg, D.; Maris, T. A. J. (Rio Grande do Sul Univ., Porto Alegre (Brazil). Instituto de Fisica). Nucl. Phys., B; 88: No. 2, 337-348(24 Mar 1975).

The quantum electrodynamics (QED) of electrons is considered as a theory with a passive dilatation which is perturbed by the electromagnetic coupling to hadrons and muons. A stability criterion is introduced and evaluated in lowest order of the perturbation. The resulting expression for the electron-muon mass ratio in terms of the vacuum polarization can be tested in e^+-e^- colliding beam experiments. (auth)

4627 ON THE DESER, GILBERT, SUDARSHAN REPRESENTATION FOR FUNCTIONS $W_i(\nu,q^2)$ (i = 1, 2) DESCRIBING THE ELECTROPRODUCTION PROCESS. Geshkenbein, B. V. (Institute for Theoretical and Experimental Physics, Moscow, USSR); Komech, A. I. (Moskovskij Gosudarstvennyj Univ. (USSR)). Phys. Lett., B; 55: No. 3, 307-310(17 Feb 1975).

The Deser, Gilbert, Sudarshan representation (D. G. S. R.) for the functions $W_i(\nu,q^2)(i = 1,2)$ are considered as equations determining spectral functions $h_i(a,\alpha)$ via the values $W_i(\nu,q^2)$ in the physical region of the electroproduction channel. It is shown that, if $W_i(\nu,q^2)$ obey the microcausality and spectrality conditions, then the equations for $H_i(a,\alpha)$ have solutions in the class of Schwartz temperated distributions and thereby the D. G. S. R. is proved. Formulae are obtained expressing spectral functions in the D. G. S. R. through the values of functions $W_i(\nu,q^2)$ in the physical region of the electroproduction channel. (auth)

4628 THE TWO-PHOTON PARTICLE PRODUCTION MECHANISM. Physical Problems. Applications. Equivalent Photon Approximation. Budnev, V. M.; Ginzburg, I. F.; Meledin, G. V.; Serbo, V. G. (AN SSSR, Novosibirsk. Inst. Matematiki). Phys. Rep.; 15: No. 4, 181-282(Jan 1975).

This review deals with the physics of two-photon particle production and its applications. Two main problems are discussed: first, what can one find out from the investigation of the two-photon production of hadrons and how, and second, how can the two-photon production of leptons be used? The basic method for extracting information on the $\gamma\gamma \to h$ (hadrons) transition – the $ee \to eeh$ reaction – is discussed in detail. In particular, the information on the $\gamma\gamma \to h$ transition which can be extracted from the related experiments and how it can be done are discussed. One examines which questions in hadrodynamics and photohadron interaction physics can be answered by such investigations. It is emphasized that their main pecularity is the possibility of investigating dependence of the amplitude on the energy as well as on the masses of both colliding particles (photons). The applications of two-photon lepton production in experimental high energy physics are discussed (the form factor investigation, the search for the real part of some forward scattering amplitudes, some auxiliary problems, etc.). Applications to the search for new (hypothetical) particles are considered. A number of important differential distributions are given. Cross section estimations for different experimental set ups are obtained. A critical discussion of the equivalent photon approximation is given. (auth)

4629 DO WE SEE ANOMALOUS DIMENSIONS IN e^+e^- INCLUSIVE ANNIHILATION AT Q = 4 GeV. Rittenberg, V. (Rockefeller Univ., New York (USA)); Schiller, D. H. (Hamburg Univ. (F. R. Germany). 2. Inst. fuer Theoretische Physik). Nucl. Phys., B; 87: No. 3, 480-484(10 Mar 1975).

It is shown in the framework of scale invariant models that a simple ansatz for the anomalous dimensions allows the experimentally observed variation with Q of the one-charged particle inclusive cross section to be determined. The calculation sheds no light on the behavior of σ_{had} with Q since the calculations were performed with the inclusive cross section normalized to the experimentally measured σ_{had}. (auth)

4630 ELECTRON–POSITRON ANNIHILATION INTO PIONS IN AN ANALYTIC MODEL OF CURRENT-HADRONIC INTERACTIONS. Moffat, J. W.; Savaria, P.; Wright, A. C. D. (Toronto Univ., Ontario (Canada). Dept. of Physics). Nucl. Phys., B; 87: No. 3, 461-479(10 Mar 1975).

An analytic model is presented for virtual pion Compton scattering. Using factorization of the Regge residues the scale-invariant electroproduction structure functions are predicted for $e^-\pi \to e^-X$, and results obtained for the pion form factor that compare well with the data. By fitting recent data from CEA and the SLAC-LBL-SPEAR collaboration for the ratio $R = \sigma(e^+e^- \to \text{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)$, and for the mean multiplicity of charged pions, predictions are obtained for the inclusive process $e^+e^- \to \pi^-X$. In particular, the predicted $E_\pi d^3\sigma/dp^3$ for the inclusive process $e^+e^- \to \pi^-X$ shows a strong diffractive type of behavior with a slope for $\sqrt{q^2} \sim 4.8$ GeV approximately the same as in $pp \to \pi^-X$. The ratio R is predicted to rise linearly versus $\sqrt{q^2}$ until some high energy, beyond which it tends to a constant, while the multiplicity remains essentially constant. The mechanism in the model that produces these predictions is the build-up or "statistical bootstrapping" of meson resonances in the direct (or missing mass) s-channel. (auth)

4631 TESTING WEAK NEUTRAL CURRENTS IN LONGITUDINALLY POLARIZED COLLIDING BEAMS. Mikaelian, K. O. (Case Western Reserve Univ., Cleveland, Ohio (USA)). Phys. Lett., B; 55: No. 2, 219-223(3 Feb 1975).

The effects of a weak neutral current as they show up in longitudinally polarized colliding beams are studied. The reactions considered are $e^+e^- \to \mu^+\mu^-$ and $e^+e^- \to \pi^+\pi^-$. The electromagnetic background and means to suppress this are also discussed. (auth)

4632 A POLE MODEL CALCULATION OF THE PHOTOPRODUCTION MULTIPOLES IN THE $\Delta(1220)$ REGION. Olsson, M. G.; Osypowski, E. T. (Wisconsin Univ., Madison (USA). Dept. of Physics). Nucl. Phys., B; 87: No. 3, 399-412(10 Mar 1975).

A simple pole model for photoproduction based on a chiral Lagrangian is presented which accounts for the essential features of all of the multipoles in the $\Delta(1220)$ region. A general form for Δ contributions is considered, and two parameters Y and Z related to different possible Δ couplings are determined to be $Y = \frac{1}{4} \pm \frac{1}{4}$ and $Z = 0 \pm \frac{1}{4}$. (auth)

4633 MAYBE THE QUARK-PARTON MODEL CAN SURVIVE ELECTRON–POSITRON ANNIHILATION. West, G. B.

(Los Alamos Scientific Lab., N. Mex. (USA)). Phys. Lett., B; 55: No. 2, 195-200(3 Feb 1975).

It is demonstrated that many of the strange features of the e^+e^- annihilation data are explicable in terms of a kinematic phase space effect in a covariant QPM. Using reasonable parameters (i.e., consistent with deep inelastic data) large violations of scaling can be expected at present energies ($\lesssim$30 GeV^2) and even at ultra high energies ($\lesssim$100 GeV^2) asymptopia may not be reached. On the other hand, the large values of R (∞) and the ratio of neutral to charged energy remain mysterious; in this model, the former indicates a relatively large number of elementary charged particles. (auth)

4634 INCLUSIVE PION DISTRIBUTIONS IN e^+e^- ANNIHILATION FROM SUM RULES AND DUALITY. Greco, M.; Srivastava, Y. N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Phys. Lett., B; 55: No. 2, 207-211(3 Feb 1975).

The threshold behavior of pion production presented in earlier work is successfully compared with the new SPEAR data. By using duality and sum rules $F_L^{(\pi+)}(\chi) \sim F_T^{(\pi+)}(\chi) \sim F_L^{(\pi^0)}(\chi) \gg F_T^{(\pi^0)}(\chi)$ for χ near 1 are derived. An accompanying result is $\sigma_\pi A_2(s) \sim 2\sigma_{\pi\mu}(s) \sim 4\sigma_{\pi\pi}(s) \sim 9\,(m_\pi^2/s)^3\,\sigma_{\mu\bar{\mu}}$ for large s. (auth)

4635 DETAILED W^0 EFFECTS IN $e^+e^- \to e^+e^-$. Budny, R. (Stanford Univ., Calif. (USA). Inst. of Theoretical Physics). Phys. Lett., B; 55: No. 2, 227-231(3 Feb 1975).

The predicted cross section for the reaction $e^+e^- \to e^+e^-$ is presented assuming one photon and W^0 exchange. Pure W^0 terms and the W^0 width are included. (auth)

4636 UNSUBTRACTED DISPERSION RELATION FOR THE LONGITUDINAL COMPTON AMPLITUDE. Bernabeu, J. (European Organization for Nuclear Research, Geneva (Switzerland)); Tarrach, R. (Barcelona Univ. (Spain). Departamento de Fisica Teorica). Phys. Lett., B; 55: No. 2, 183-186(3 Feb 1975).

It is shown that there is a simple connection between the slope, at $q^2 = 0$, of the longitudinal Compton amplitude and the electric polarizability of the nucleon. The longitudinal subtraction function is thus known to order q^2. The assumption of an unsubtracted dispersion relation for the longitudinal amplitude leads to a sum rule for the electric polarizability. This is a model independent test of the high energy behavior of the forward virtual Compton amplitude. (auth)

4637 Z BOSON EFFECTS IN ELECTRON POSITRON SCATTERING AT EPIC ENERGIES AT 14 GeV. Spathis, G. D. (Sussex Univ., Brighton (UK). School of Mathematical and Physical Sciences). Nucl. Phys., B; 87: No. 2, 351-364(3 Mar 1975).

The problem of testing the intermediate vector boson effects in the reactions $e^-e^+ \to e^-e^+ +$ hadrons, $e^-e^+ \to e^-e^+ + \mu^-\mu^+$, $e^-p \to e^-x$ with the next generation of accelerators is discussed, and it is concluded that these reactions must be considered. The differential cross sections for the one lepton at large four-momentum transfer are obtained, and a significant contribution of Z effects is found. (auth)

Weak

Refer also to abstracts 4365 and 5171.

4638 (COO-1428-413) SINGLE-PION PRODUCTION IN CHARGED-CURRENT NEUTRINO INTERACTIONS AT A. N. L. Garfinkel, A. F. (Purdue Univ., Lafayette, Ind. (USA). Dept. of Physics). 1973. 10p. (CONF-750307-2). Dep. NTIS $4.00.

From international colloquium of the CNRS on neutrino physics at high energy; Paris, France (18 Mar 1975).

Preliminary results are presented on the production of single pions by the interaction of neutrinos on protons and neutrons through the weak interaction charged current. The observation of three independent reactions in the 12-foot bubble chamber at Argonne National Laboratory allows the study of the isospin structure of the weak charged current. (tr-auth)

4639 (COO-3071-138) HEAVY NEUTRAL LEPTONS AS A SOURCE OF DIMUONS IN NEUTRINO SCATTERING. Chang, L. N.; Derman, E.; Ng, J. N. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 1975. 30p. Dep. NTIS $4.50.

The observation of dimuon pairs in high energy neutrino and antineutrino scattering at F. N. A. L. has recently been announced. The possibility is considered that these muons are due to the production of a new neutral heavy lepton and its subsequent decay into a dimuon pair and a neutrino. The total cross section was calculated for such production, as well as various distributions for the dimuon pairs and for the recoil hadronic mass, for several incoming neutrino energies and several heavy lepton masses. Currently available data are displayed together with the predictions of this model. (auth)

4640 (COO-3071-140) DIMUON PAIRS AS A SIGNAL FOR NEUTRAL HEAVY LEPTON PRODUCTION. Chang, L. N.; Derman, E.; Ng, J. N. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 1975. 20p. Dep. NTIS $4.00.

The possibility that dimuon pairs recently observed in high energy nu(anti nu) – N scattering are due to the production of a neutral heavy lepton is considered. The distributions are calculated for various measurable quantities and displayed together with the available data. (auth)

4641 (DESY-75/02) COLOR VERSUS CHARM. Kitakado, S.; Walsh, T. F. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Jan 1975. 9p. INIS.

We discuss the decay systematics (including inclusive decays) of the new mesons seen in e^+e^- collisions. Our aim is to show how one can substantiate or demolish the color scheme, which we contrast to the charm model. (auth)

4642 (JINR-E2-8432) MODEL-INDEPENDENT TESTS FOR $\Delta I = \frac{1}{2}$ RULE IN Σ DECAYS. Ion, D. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 25p. Dep. NTIS (US Sales Only) $4.25.

The equalities resulting from the triangular relations and certain tests for the $\Delta I = \frac{1}{2}$ rule in Σ decays were investigated. Numerical results and an estimation of the $\Delta I = \frac{1}{2}$ breaking are presented. It is found that a single breaking parameter may account for the departures from the exact $\Delta I = \frac{1}{2}$ rule for both the parity-violating and the parity-conserving decay amplitudes. The additional constraints imposed on the experimental data, when the decay amplitudes are taken to be real, are discussed. (auth)

4643 (JINR-E2-8472) GENERALIZED WEINBERG SUM RULE AND WIDTHS OF DECAY OF NEW NEUTRAL VECTOR MESONS INTO LEPTON–ANTILEPTON PAIRS. Gerasimov, S. B.; Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

The use of the generalized Weinberg sum rules makes it possible to estimate the widths of decay into lepton-antilepton pairs for new neutral vector mesons predicted by the symmetric three-triplet hadron model. The value found for the decay width of the new ω_m meson equals 9^{+1}_{-5} keV and is rather consistent with the experimental data on the recently discovered $\Psi(3105)$ meson. Predictions are made for other new vector neutral ρ^0_m and ϕ_m mesons. (auth)

4644 (ORO-3992-208) LEPTON–LEPTON SCATTERING IN A SPONTANEOUSLY BROKEN GAUGE THEORY SATISFYING STRONG INTERACTION DUALITY. Dicus, D. A.; Teplitz, V. L.; Young, J. E. (Texas Univ., Austin (USA). Center for Particle Theory). 1974. Contract AT(40-1)-3992. 46p. (CPT-252). Dep. NTIS $5.50.

A spontaneously broken gauge theory of leptons (e, mu, nu/sub e/, nu/sub mu/) is constructed in which the two-body scattering amplitudes are dual. The resultant model leads to suppression of nu/sub mu/ + e yields nu/sub mu/ + e and predictions for nu/sub e/ + e yields nu/sub e/ + e and e + e yields mu^+mu^- that are distinctly different from those of both the conventional V – A theory and the Weinberg-Salem model. (auth)

4645 PARTON MODEL AND DEEPLY INELASTIC PROCESSES ON NUCLEI. Zakharov, V. I.; Nikolaev, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 2, 434-445(Feb 1975). (In Russian).

Deeply inelastic scattering of leptons on nuclei is treated in the parton model. It is shown that for $x \leq 0.05 - 0.1$ the scattering cross section of the virtual photon by a nucleus exceeds the sum of the cross sections of scattering on separate nucleons of the nucleus, i.e., the antiscreening takes place. The sum rule for structure functions is obtained: $\int dx F_{\gamma A}(x) = Z\int F_{\gamma p}(x)dx + (A - Z)\int F_{\gamma n}(x)dx$. (auth)

4646 NEUTRAL CURRENT AND THE SIGN OF THE WEAK INTERACTION CONSTANT. Bilen'kii, S. M.; Dadayan, N. A.; Khristova, E. Kh. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 360-366(Feb 1975). (In Russian).

The results of a calculation of various two-particle correlations in the production of leptonic pairs in a neutrino beam are presented. (auth)

4647 THEORETICAL EVIDENCE FOR A NEW WEAK CURRENT. Pappas, R.; Wellner, M. (Physics Department, Syracuse University, Syracuse, New York 13210). Phys. Rev. D 11: No. 2, 318-321 (15 Jan 1975).

We postulate the existence of a new weak or superweak neutral isosinglet current $\mathfrak{X}$, of the chiral form $V + A$ (the usual form being $V - A$). The observed spin-1/2 baryons' contributions to $\mathfrak{X}$ are $X = \alpha\ (N^{\dagger}N + \Xi^{\dagger}\Xi)\ + \beta\Lambda^{\dagger}\Lambda$, with parameters α and β. This form follows deductively from a compensation theory for Feynman diagrams. Observation points to a value $\beta/\alpha = 2.007 \pm 0.005$. By taking $\beta/\alpha = 2$ exactly, we derive a mass relation which allows us to calculate in a satisfactory way the mass of the Λ in terms of the masses of the N and Ξ. (auth)

4648 SUM RULES AND ULTRAVIOLET DIVERGENCES IN A GAUGE MODEL. Hagiwara, T. (Department of Physics, The City College of the City University of New York, New York, New York 10031). Phys. Rev. D 11: No. 2, 331-335 (15 Jan 1975).

By examining an induced neutral-current semileptonic process, ν + baryon → ν + baryon, in the SO(3) gauge model with strong interactions, we show with the aid of the scaling assumption that the nonexistence of ultraviolet divergences in the process is equivalent to the validity of sum rules dictated by CCC (continuity equations and commutation relations of the currents) of the model. (auth)

4649 MESON DECAY IN A THEORY OF BOUND QUARKS. Bender, C.M. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139; Guralnik, G.S.; Mandula, J.E. Phys. Rev. D 11: No. 2, 438-451 (15 Jan 1975).

A perturbative method for performing calculations in a theory of permanently bound quarks is formulated. This method is then used in first order to verify the locality of the theory and to derive an expression for the meson decay amplitudes ($M \to M_1 + M_2$). In a bound-quark model in two-dimensional space-time it is shown that the cascade decay mode ($M \gtrsim M_1 \gg M_2$) is dynamically favored over the symmetric decay mode ($M \gg M_1 \approx M_2$). (auth)

4650 LEPTONIC DECAYS OF VECTOR MESONS IN SU(4). Dicus, D.A. (Center for Particle Theory, Department of Physics, The University of Texas, Austin, Texas 78712). Phys. Rev. Lett. 34: No. 13, 846-847 (31 Mar 1975).

The sum rule on the decay of vector mesons into lepton pairs is shown to be brought into good agreement with experiment by assuming that the new ψ (3105) particle is a member of a basic SU (4) multiplet of vector mesons. (auth)

4651 K_{l3} FORM FACTORS AND (8,8) MODEL OF CHIRAL SYMMETRY BREAKING. Ali, A. (Department of Physics, Stevens Institute of Technology, Hoboken, New Jersey 07030); Razmi, M.S.K. Ann. Phys. (N.Y.) 89: No. 2, 441-450 (Feb 1975).

K_{l3} form factors are calculated in the single approximation to the spectral functions. The so-called sigma terms and current divergences are calculated in the (8,8) model of chiral symmetry breaking. Comparison with the experimental results and the $(3,3^*)+(3^*,3)$ model is made. It is concluded that it is not possible to rule out the (8,8) model in favor of the $(3,3^*)+(3^*,3)$ model at present. (auth)

4652 ASYMPTOTIC SU(4) IN THE l^+l^- ANNIHILATION OF NEW RESONANCES. Takasugi, E.; Oneda, S. (Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. Lett. 34: No. 15, 988-991 (14 Apr 1975).

The l^+l^- decays of the new narrow resonances are discussed as a good test of the hypothesis of asymptotic SU(4) and of the assignment of ψ (3105) to an uncharmed member of the set of 1^{--} mesons belonging to the $15 \oplus 1$ dimensional representation of SU(4). (auth)

4653 ELASTIC SCATTERING OF THE NEUTRINO AND ANTINEUTRINO ON THE ELECTRON. Kerimov, B. K.; Bogdanov, Yu. P.; Safin, M. Ya. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2213-2221(Oct 1974). (In Russian).

On the basis of the Weinberg Hamiltonian and the effective Hamiltonian, containing the interaction of both charged $(\nu e)(\bar{e}\nu)$ and neutral $(\nu\nu)$ $(\bar{e}e)$ currents, the angular and energy spectra of recoil electrons were calculated for the reactions $\nu_e e \to \nu_e e$, $\nu_\mu e \to \nu_\mu e$, $\bar{\nu}_e e \to \bar{\nu}_e e$, and $\bar{\nu}_\mu e \to \bar{\nu}_\mu e$; account was taken of the electron polarization and the spectra of reactor antineutrinos and antineutrinos (neutrinos) of the CERN and IHEP accelerators. Numerical evaluations were made of the coupling constants for charged and neutral currents. (1 figure, 1 table) (tr-auth)

4654 QUANTUM GRAVITY AND THE ELECTRON AND MUON ANOMALOUS MAGNETIC MOMENTS. Berends, F. A. (Rijksuniversiteit Leiden (Netherlands). Instituut Lorentz voor Theoretische Natuurkunde); Gastmans, R. (Louvain Univ. (Belgium). Inst. for Theoretical Physics). Phys. Lett., B; 55: No. 3, 311-312(17 Feb 1975).

Quantum gravity corrections at the one-loop level to the electron and muon $(g - 2)/2$ are calculated and found to be finite. (auth)

4655 RENORMALIZABILITY AND THE HIGH ENERGY BEHAVIOUR OF TOTAL CROSS SECTIONS IN THE WEINBERG SALAM MODEL. Komen, G. J. (Rijksuniversiteit Leiden (Netherlands). Instituut Lorentz voor Theoretische Natuurkunde). Phys. Lett., B; 55: No. 4, 389-392(3 Mar 1975).

It is discussed how the violation of the Pomeranchuk theorem in the Weinberg–Salam model of weak and electromagnetic interactions upsets current ideas about the convergence of dispersion relations in renormalizable field theories. (auth)

4656 MASSIVE NEUTRINOS. Davis, T. M.; Ray, J. R. (Clemson Univ., S. C. (USA)). Phys. Lett., A; 51: No. 4, 199-200(10 Mar 1975).

There have been recent discussions, associated with the solar neutrino problem, that consider the neutrino to have rest mass. Here a discussion is given of massive neutrinos in general relativity. There are no solutions to the Einstein zero mass neutrino equations for spherically-symmetric spacetimes. A spherically–symmetric solution to the Einstein–massive neutrino equations is presented. (auth)

4657 NEUTRAL CURRENTS: A FUNDAMENTAL EXTENSION OF WEAK INTERACTIONS. von Krogh, J. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.). pp 24-70 of Physics: Basis of Technology. Plenary Lectures. Weinheim, F. R. Germany; Physik Verl. (1974). (In German).

From 38th meeting of physicists'; Nuernberg, F. R. Germany (23 Sep 1974). 7 refs. With figs.

The current–current coupling by photon exchange in the electromagnetic interactions and by charged and neutral boson exchange in the weak interactions is summarized. The search for weak neutral currents in neutrino experiments is discussed in detail. The Gargamelle neutrino experiments at CERN and the counter experiments at NAL are described. The results are interpreted by Weinberg–Salam theory. (GE)

4658 NEUTRAL CURRENTS AND NEUTRINO IDENTITY. Sehgal, L. M. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.). Phys. Lett., B; 55: No. 2, 205-206 (3 Feb 1975).

The possibility is considered that in the neutral current reactions ν + target → ν' + ..., the final neutrino ν' may be distinct from the initial neutrino ν. A test of neutrino identity is proposed based on the scattering of low energy (reactor) antineutrinos $\bar{\nu}_e$ from an electron target. (auth)

4659 BOUNDS ON THE COUPLING CONSTANTS OF THE NEUTRAL CURRENT. Rajasekaran, G.; Sarma, K. V. L. (Tata Inst. of Fundamental Research, Bombay (India)). Phys. Lett., B; 55: No. 2, 201-204(3 Feb 1975).

Bounds were derived on the coupling constants which characterize the strengths of the various pieces of the weak hadronic neutral current using isospin invariance of strong interactions alone. For the numerical evaluation of the bounds with present experimental data, Bjorken scaling also was used. (auth)

4660 MODELS FOR THE WEAK PARITY-VIOLATING VECTOR MESON EXCHANGE POTENTIAL AND THE CIRCULAR POLARIZATION IN n + p → d + γ. Pirner, H. J.; Rustgi, M. L. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 3, 427-439(3 Mar 1975).

Three models are proposed which lead to a p.v. nucleon–nucleon interaction mediated by charged and neutral vector mesons. Besides the ad hoc hypothesis of octet dominance, two quark models are considered (the Bose quark and color Fermi quark model), which give a dynamical explanation of the $\Delta I = \frac{1}{2}$ rule in strangeness-changing hyperon decays. They lead to p.v. potentials with different isospin dependence. The weak $N\bar{N}\rho^0$ coupling is also derived from an SU(2) × U(1) gauge theory with neutral currents. The circular polarization P_γ of the γ-quanta in the capture of thermal neutrons on protons is calculated for these different models. The Reid hard-core (HC) and soft-core (SC) potentials have been chosen to take into account the strong interaction. Then the naively factorized Cabbibo current–current interaction with charged ρ exchange only gives $P_\gamma^{HC} = -2.7 \times 10^{-8}$ and $P_\gamma^{SC} = -2.1 \times 10^{-8}$. The strong octet dominance and Bose quark model lead to a vanishing circular polarization $|P_\gamma| \sim (1 - 4) \times 10^{-9}$. The colour Fermi quark model enhances the circular polarization and gives $P_\gamma \sim -5 \times 10^{-8}$. (auth)

Strong (General)

4661 (COO-3065-112) SU(4), SU(8) MASS FORMULAS AND WEAK INTERACTIONS. Okubo, S. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy). 1975. 34p. Dep. NTIS $4.75.

Mass formulas for SU(4) and SU(8) groups were obtained, and are especially very simple for degenerate representations. Also,

tensor representations of baryon multiplets are discussed together with some applications to weak decay processes. (auth)

4662 (CRN/HE-74-13) QUARKS FOR HADRONS AND LEPTONS. Leite Lopes, J. (Centre National de la Recherche Scientifique, 67-Strasbourg (France). Centre de Recherches Nucleaires; Strasbourg-1 Univ., 67 (France)). 1974. 8p. Dep. NTIS (US Sales Only) $4.00.

A report is made on an attempt to formulate a unified model of quarks for hadrons and leptons. The argument is based on a comparison between the muon-electron and the $K^{*-}-\rho^{-}$ mass difference. This model predicts the existence of spin $^3/_2$ leptons. (JFP)

4663 (JINR-E2-8742) COLLECTIVE RESONANCE PHENOMENON IN HADRONIC SYSTEMS. Kuz'min, V. A.; Lobashev, V. M.; Matveev, V. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The possibility of the existence of collective vibrations in hadronic matter and some feasible implications is discussed. A quark model is considered in which such vibrations could occur. Within the framework of the model as a consequence of collective effects one tries to explain the behavior of $e^{+}e^{-}$-annihilation cross section into hadrons in analogy with the giant resonance phenomenon in nuclear photoabsorption reactions. The investigation was performed at the Laboratory of Theoretical Physics, JINR. (auth)

4664 (LBL-3697) STRONG INTERACTIONS, ZWEIG'S RULE, AND WEAKER INTERACTIONS. Godfrey, G. L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1975. Contract W-7405-eng-48. 8p. Dep. NTIS $4.00.

An attempt is made to connect five notions: Strong interaction scattering amplitudes do not involve the action of a Hamiltonian and are only Clebsch-Gordan coefficients. The four momentum P is an SU(something) operator. The four momentum of a quark does not change in a strong interaction scattering. Zweig's rule. Gluons should not be drawn in strong interaction scattering diagrams. Finally, a simple explanation will be offered for the weak interaction of leptons among themselves and with hadrons. (auth)

4665 (RL-75-024) MESON AND THE BARYON LOOP TO MAKE THE POMERON. Pennington, M. R.; Gula, A. (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 16p. (T-106). Dep. NTIS (US Sales Only) $4.00.

A discussion is given of how the baryon loop is the necessary complement of the crossed meson loop in dual quark models of the pomeron. This scheme requires the existence of a four-quark meson trajectory with a spin 2 state close to $\bar{p}p$ threshold. Recent experimental indications that the pomeron may be different in MM, MB and BB processes are naturally explained. (auth)

4666 SEMI-LOCAL DUALITY ESTIMATE OF THE TRIPLE-REGGE COUPLING OF THREE-MESON TRAJECTORIES. Sorensen, C. (Technische Hochschule, Zurich). Nuovo Cim.; 26A: No. 1, 59-71(1 Mar 1975).

Semi-local duality in Reggeon-particle scattering is used to establish the magnitude and small-t dependence of the triple-Regge couplings of three (nonpomeron) meson trajectories. Simple analytic formulas in terms of a few known parameters are given. (auth)

4667 LADDER APPROXIMATION, SCALAR-EXCHANGE MESONS, AND BETHE-SALPETER SCATTERING STATES. Hormozdiari, I. (Physics Department, Pahlavi University, Shiraz, Iran); Huang, J.C. Phys. Rev. D 11: No. 2, 348-352 (15 Jan 1975).

We investigate the conditions under which the Bethe-Salpeter equation with a scalar-exchange interaction (in the ladder approximation) will in the small-relative-time limit give rise to scattering states. Our results indicate that the exchange particle should be at least slightly unstable (nonzero full width Γ). The role of Γ is compared with cutoff factors occurring in nonrelativistic potential scattering. (auth)

4668 SPIN STRUCTURE OF DUAL-RESONANCE SPECTRA. Austen, G.J.M.; Dullemond, C.; Vervoort, P.M. (University of Nijmegen, Nijmegen, The Netherlands). Phys. Rev. D 11: No. 2, 353-360 (15 Jan 1975).

A study is made of certain aspects of the spin structure of dual-resonance spectra. Generating functions and recurrence relations are derived which give the multiplicities of internal physical states of definite spin and parity in the conventional dual resonance model, the model of Neveu and Schwarz, and that of Ramond. Certain regularities common to these models are noted. (auth)

4669 COORDINATES AS DYNAMICAL VARIABLES: A POSSIBLE DESCRIPTION OF STRONG INTERACTIONS. Domokos, G. (Department of Physics, The Johns Hopkins University, Baltimore, Maryland 21218). Phys. Rev. D 11: No. 2, 373-387 (15 Jan 1975).

As a possible generalization of dual resonance models, a description of strong interactions is proposed in terms of q-number coordinates. Some basic properties of the latter are conjectured by abstraction from dual resonance models and on the basis of a correspondence principle. Fields on q-number coordinates are defined; interaction between matter fields and coordinate fluctuations is obtained from a covariance argument. Feynman rules are derived for the calculation of Green's functions. Two explicit examples are worked out as an illustration. It is shown in particular that a certain type of dual resonance amplitudes may be recovered as an approximate solution. (auth)

4670 HAMILTONIAN FORMULATION OF WILSON'S LATTICE GAUGE THEORIES. Kogut, J. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853); Susskind, L. Phys. Rev. D 11: No. 2, 395-408 (15 Jan 1975).

Wilson's lattice gauge model is presented as a canonical Hamiltonian theory. The structure of the model is reduced to the interactions of an infinite collection of coupled rigid rotators. The gauge-invariant configuration space consists of a collection of strings with quarks at their ends. The strings are lines of non-Abelian electric flux. In the strong-coupling limit the dynamics is best described in terms of these strings. Quark confinement is a result of the inability to break a string without producing a pair. (auth)

4671 THEORIES OF PERMANENTLY BOUND QUARKS. Bender, C. M.; Mandula, J. E.; Guralnick, G. S. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Phys. Rev. D 11: No. 2, 409-428(15 Jan 1975).

A relativistic theory of permanently bound quarks is studied. A covariant wave equation is formulated which describes a system of bound spin-0 constituents. The bound states of quarks are found to lie on approximately linear Regge trajectories. Locality and the cluster decomposition property are discussed in the context of these theories. Multimeson states are described. Procedures for calculating form factors and structure functions are outlined. This paper concludes that theories of permanently bound quarks are physically acceptable relativistic particle theories. (auth)

4672 QUANTUM DYNAMICS OF THE RELATIVISTIC STRING. Rohrlich, F. (Department of Physics, Syracuse University, Syracuse, New York 13210). Phys. Rev. Lett. 34: No. 13, 842-845 (31 Mar 1975).

The equations characterizing the orthogonal gauge do not restrict the spatial degrees of freedom. This observation leads to Poincaré invariance in $s+1$ dimensional space for any s. The absence of a tachyonic ground state and of ghosts is derived from algebraic consistency. (auth)

4673 CLUSTER PRODUCTION IN HIGH ENERGY REACTIONS. Miesowicz, M. (Inst. of Nuclear Physics, Krakow); Sosnowski, R. (Nukleonika; 20: No. 1, 25-41(1975).

The first indications coming from the interactions of cosmic rays and suggesting that secondary particles produced in high-energy collisions are decay products of heavy intermediate bodies (clusters) are discussed. Also, those aspects of experimental data from the accelerator energy region that support the hypothesis of cluster production are presented. It is stressed that data on high-energy interactions with nuclei support this hypothesis. (11 figures) (auth)

4674 STATISTICAL THERMODYNAMICS OF STRONG INTERACTIONS. Hagedorn, R. (CERN, Geneva). pp 255-296 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

Lectures are given on the statistical thermodynamics of strong interactions at high temperature and high density. They are qualitative rather than quantitative. Included are the phenomenology of strong interactions, applications to big bang cosmology, and a guide to the literature on the statistical bootstrap model (thermodynamic model) of strong interactions. (JFP)

4675 REGGEON CALCULUS RULES FOR THE TRIPLE REGGE REGION. Cardy, J. L.; Sugar, R. L. (California Univ., Santa Barbara (USA). Dept. of Physics); White, A. R. (California Univ., Berkeley (USA). Dept. of Physics). Phys. Lett., B; 55: No. 4, 384-388(3 Mar 1975).

It is shown that Reggeon unitarity is sufficient to determine the Reggeon calculus rules for the one-particle inclusive cross section in the triple-Regge region. The central result is that only one vertex in each Reggeon diagram does not conserve $E = 1 -$ angular momentum. The rules, which are most easily expressed using Rayleigh-Schroedinger perturbation theory, lead to a simple closed expression for the inclusive cross section. (auth)

4676 AN OPERATOR FORMULATION OF THE PARTON MODEL. Curtright, T. L. (California Inst. of Tech., Pasadena (USA)); Mandula, J. E. (Massachusetts Inst. of Tech., Cambridge (USA)); Ravndal, F. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Phys. Lett., B; 55: No. 4, 393-396 (3 Mar 1975).

A compact and covariant formulation of the basic assumptions of the parton model is given in terms of field operators. Illustrative examples of the applications of these assumptions to current-induced processes are given. (auth)

4677 A BOOTSTRAP OF SINGLE DIFFRACTIVE AND NON-DIFFRACTIVE EXCITATIONS. Bishari, M. (Weizmann Inst. of Science, Rehovoth (Israel)). Phys. Lett., B; 55: No. 4, 400-404(3 Mar 1975).

In the context of S-matrix theory, general principles, namely unitarity, analyticity and crossing, are used to derive sum rules for triple Reggeon couplings. The sum rules relate the strengths of inclusive single-particle diffractive and non-diffractive processes. It is shown that the smallness of diffractive couplings may be related to the relatively small observed average transverse momenta. (auth)

4678 ENHANCEMENT OF NON-LEPTONIC DECAYS OF CHARMED PARTICLES. Altarelli, G.; Maiani, L. (Ecole Normale Superieure, 75 - Paris (France)); Cabibbo, N. (Rome Univ. (Italy). Istituto di Fisica). Nucl. Phys., B; 88: No. 2, 285-288(24 Mar 1975).

It is suggested that nonleptonic decays of charmed particles are enhanced over semi-leptonic decays by a sizeable factor, in analogy with the situation encountered in strange particle decays. This conjecture is verified in a model of octet enhancement based on asymptotically-free gauge theories of strong interactions. Arguments are given to support a specific SU(3) behavior of the enhanced part of the nonleptonic Hamiltonian for charmed particle decays. Consequent selection and intensity rules are discussed. (auth)

4679 STATISTICAL BOOTSTRAP OF NON-SPHERICAL FIREBALLS. Montvay, I. (Roland Eotvos Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 37: No. 1-2, 61-74(1974).

The integral equations determining the hadron distribution emerging from a fireball are modified to allow a nonspherical shape. A specific model with built in transversal cut-off is investigated in more detail, and the connection with other statistical models is briefly discussed. (auth)

Strong (Baryon No. = 0)

4680 (COO-1545-154) MULTIPARTICLE PRODUCTION THROUGH ISOSCALAR CLUSTERS. Armburst, W. T.; Scott, D. M. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1975. Contract AT(11-1)-1545. 23p. Dep. NTIS $4.25.

The isoscalar cluster model for multiparticle production was extended to include clusters of A_2 meson pairs in addition to previously studied rho-rho and sigma clusters. The production of each type of cluster is given by an energy dependent Poisson distribution. The Poisson parameters determined from the charged particle multiplicity distributions indicate that the inclusion of A_2-A_2 clusters does not improve the fit to the data. The predictions of the model for n_0 n/sub -/, f/sup 2//sub -,-/, and f/sup 2//sub 0,0/ compare favorably to the experimental values. (auth)

4681 (COO-1545-156) DUALITY VIOLATION AND THE PRODUCTION AND DECAY OF NEW AND OLD MESONS. Bolzan, J. F.; Geer, K. A.; Palmer, W. F.; Pinsky, S. S. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1975. Contract AT(11-1)-1545. 15p. Dep. NTIS $4.00.

It is shown that the O-meson, the J/sup P/ equals 1^- daughter of the Pomeron considered by Freund and Nambu, is quite successful in predicting a number of rates for duality violating processes via pole dominance. In particular, the production of psi(3105) at BNL, and the production of the phi at ANL are in good agreement with the model. The branching ratio of psi(3105) to anti pp observed at DESY is estimated, and a number of other interesting processes are calculated using other mesons on the tower of the $0(1^-)$. (auth)

4682 (DESY-74/63) THE WIDTH OF $\Psi(3105)$. Kitakado, S.; Orito, S.; Walsh, T. F. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Dec 1974. 5p. INIS.

We extend a weakly broken nonet symmetry of the vector mesons to SU(4) so as to include a new c, $\bar{c}$ state Ψ. From the masses we determine the mixing among Φ, ω, Ψ and thereby estimate $\gamma(\Psi \to \text{hadrons})$ approximately 60 keV. We discuss the significance of this for the case of a symmetry as badly broken as SU(4) must be if the new meson at 3.1 GeV is $c,\bar{c}$. (auth)

4683 (ITF-74-150P) COLLECTIVE VARIABLES AND PATH INTEGRALS. Gonopol'skii, O. L. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 26p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

The method of collective variables for the quantum systems is generalized. The ρ-particle density matrix of the system of quantum charged particles submitted to the Boltzmann statistics applying the path integrals is calculated. By introducing the ρ-particle transition function to the collective variables, the expression for the ρ-particle density matrix as the ρ-particle path integral, is obtained. This integral is appreciated in the approximation of direct paths. (auth)

4684 (JINR-E2-8252) ABOUT $X^0(958)$ SPIN DETERMINATION IN THE REACTION $K^-p \to X^0\Lambda$. Lednicky, R. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 25p. Dep. NTIS (US Sales Only) $4.25.

It is shown that the absence of anisotropies in the Adair distributions for the reaction $K^-p \to X^0\Lambda$ at 1.75 GeV/c ($\cos\theta_{c.m.} > 0.6$) does not imply pseudoscalarity of the X (958)-meson. Furthermore, an indication of the opposite character of the anisotropies at 1.75 GeV/c ($\cos\theta_{c.m.} > 0.6$) compared to those at 2.18 GeV/c ($\cos\theta_{c.m.} > 0.98$) is interpreted as a new argument in favor of the spin-2 X^0-meson assignment. More pronounced anisotropies at 1.75 GeV/c can be expected in the interval $0.4 \lesssim \cos\theta_{c.m.} \leq 0.8$. The joint distribution of all the X^0-meson and Λ-decay characteristics was obtained; the likelihood analysis of this distribution, instead of the one-dimensional Adair analysis, is suggested. (auth)

4685 (JINR-P2-8659) ELECTROMAGNETIC FORM FACTORS OF K-MESON. Volkov, M. K.; Matafonov, V. B.; Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 15p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The form factors and the mean-square radii of kaons $\langle r^2\rangle_{K^+} = +0.38\ f^2$; $\langle r^2\rangle_{K^0} = -0.08\ f^2$ are calculated in the chiral quantum theory. (auth)

4686 d-WAVE IN $\pi\pi$ SCATTERING IN LOW ENERGY REGION. Vall, A. N.; Parfenov, Yu. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 367-372(Feb 1975). (In Russian).

A simple description of the d wave in the $\pi\pi$ scattering is achieved in the framework of the low energy dispersion model. It is shown that taking into account all the resonances lying on the ρ trajectory gives a wonderful agreement with low energy assumptions. (auth)

4687 PREDICTIONS OF QUARK AND DUAL APPROACHES TO MESON CLASSIFICATION. Frampton, P.H. (Department of Physics, Syracuse University, Syracuse, New York 13210). Phys. Rev. Lett. 34: No. 13, 840-842 (31 Mar 1975).

At the six lowest-lying levels, the quark model predicts a sequence $L=0,1,2,...$of meson states with specific J^{PC} coupling to two and three pions. The symmetric-group model gives exactly the coincident prediction for the J^{PC} sequence. The Neveu-Schwarz model is missing two states at these levels; the new states, predicted by both dual and quark models, are the $J^{PC} = 0^{++}$, $^3P_0$ isoscalar daughter of $f(1250)$, and the $J^{PC}=1^{+-}$, $^1P_1$ isoscalar partner of B (1235). (auth)

4688 SELF-CONSISTENT BINDING FORCE BETWEEN QUARKS IN ONE DIMENSION. Bender, C.M.; Mandula, J.E. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Guralnik, G.S. Phys. Rev. D 11: No. 2, 429-437 (15 Jan 1975).

A relativistic theory of permanently bound quarks in one dimension is formulated and studied. The explicit solutions of the theory are used to verify that a long-range force between the quarks arises self-consistently. (auth)

4689 HOW HEAVY ARE THE QUARKS? Cheng, T.P.; James, P.B. (Department of Physics, University of Missouri-St. Louis, St. Louis, Missouri 63121). Phys. Rev. Lett. 34: No. 14, 917-919 (7 Apr 1975).

We consider a simple model of mesons as Coulombic bound states of quark-antiquark pairs confined in a box. A fit to the meson spectra and decay rates suggests that $m_u = m_d \simeq 0.3$ GeV, $m_s \simeq 0.4$ GeV, and $m_c \simeq 1.4$ GeV. We also predict new meson systematics and metastable charmed baryons. (auth)

4690 COLORFUL ψ's. Bars, I.; Peccei, R.D. (Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. Lett. 34: No. 15, 985-988 (14 Apr 1975).

We suggest that the recently discovered long-lived particles ψ (3105) and ψ (3695) are members of a family of "colored" vector mesons. Our scheme is a natural generalization of $SU(6) \otimes SU(3)'$. The narrow widths of these states are understood because of color conservation and the difficulty of radiating colored photons. The spectroscopy of these new colored states, which is very rich, is discussed along with predictions for photoproduction. (auth)

4691 COMMENTS ON TWO-CHANNEL UNITARITY. Alvarez-Estrada, R. F.; Carreras, B.; Mahoux, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique). Nucl. Phys., B; 88: No. 2, 289-300(24 Mar 1975).

The continuous ambiguity in theoretical phase-shift analysis is studied and removed in the special case of two coupled channels with two spinless particles. Certain supplementary conditions to be satisfied by the phases of the scattering amplitudes in order to have fully unitary amplitudes are also discussed. (auth)

4692 ON THE DIFFERENTIAL CROSS SECTION AND THE SLOPE OF VECTOR MESON ELECTROPRODUCTION. Fraas, H. (Wuerzburg Univ. (F. R. Germany). Physikalisches Inst.); Read, B. J. (SEE CODE-5677740 Science Research Council, Daresbury (UK). Daresbury Nuclear Physics Lab.); Schildknecht, D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Nucl. Phys., B; 88: No. 2, 301-317(24 Mar 1975).

The effect of higher mass vector meson contributions (e.g., transitions $\rho' p \to \rho p$, $\rho'' p \to \rho p$ etc.) on diffractive vector meson electroproduction is investigated. The ansatz for these off-diagonal transitions is motivated from diffractive dissociation results in ρp and pp interactions and recent treatment of the total electroproduction cross section with inclusion of off-diagonal terms. For $t = 0$ and large q^2 ($\omega' \gtrsim 10$), comparing with simple ρ^0 dominance, a change in normalization, but the same power of q^2 dependence is found. From results on slopes in diffraction dissociation in πp and pp interactions some flattening of the ρ^0 electroproduction slope with increasing q^2 is predicted in the region of small $-t$. (auth)

4693 $\pi\pi$ AND $K\bar{K}$ PHASE-SHIFT ANALYSIS AND SCALAR RESONANCES. Yndurain, F. J. (Universidad Autonoma de Madrid (Spain)). Nucl. Phys., B; 88: No. 2, 318-336(24 Mar 1975).

The ambiguities and instabilities connected with lack of completeness in the experiments used to obtain phase shifts for the processes $\pi\pi \to \pi\pi$, $\pi\pi \to K\bar{K}$, $K\bar{K} \to K\bar{K}$ in the medium-energy range are analyzed, particularly in connection with scalar resonances. It is shown that multibody processes like $\pi\pi \to 4\pi$, and the influence of the channel $K\bar{K} \to K\bar{K}$ are greater than is usually speculated. Possible remedies are also discussed. (auth)

4694 A LOWER BOUND TO THE $\pi^0\pi^0$ S-WAVE SCATTERING LENGTH. Lopez, C. (Paris-6 Univ., 75 (France). Lab. de Physique Theorique et Hautes Energies). Nucl. Phys., B; 88: No. 2, 358-364(24 Mar 1975).

A new lower bound to the $\pi^0\pi^0$ S-wave scattering length is found in terms of the D-wave scattering length. The main ingredients of the method are the Roy exact partial-wave equations and an extensive use of unitarity in the physical region. For a value of $a_2 = 7.3 \times 10^{-4}$, the bound $a_0 \gg -0.33$ is obtained. (auth)

4695 MULTIHADRON PRODUCTION IN NUCLEON–ANTINUCLEON ANNIHILATION AT REST IN THE STATISTICAL BOOTSTRAP MODEL. II. Momentum Distributions, Average Energies, and Transverse Momenta. Moehring, H. J. (Leipzig Univ. (German Democratic Republic). Physikalisches Inst.). Nucl. Phys., B; 87: No. 3, 509-526(10 Mar 1975).

Inclusive, semi-inclusive, and exclusive invariant single particle distributions and average transverse momenta and energies are discussed in the statistical bootstrap model. The shape of inclusive distributions and average transverse momenta are confronted with available data on $\bar{p}p$, $\bar{p}n$ and e^+e^- annihilations. Good agreement is found using the parameter of the model as determined in part I from the multiplicity distribution in $\bar{p}p$ annihilation at rest. Furthermore the approach to the asymptotic behavior in the statistical bootstrap model is discussed. (auth)

4696 A PARTIAL WAVE ANALYSIS OF THE Q ENHANCEMENT IN THE REACTION $K^-p \to K^-\pi^-\pi^+p$ AT 3.95 GeV/c. Drevillon, B.; Borenstein, S.; Rouge, A.; Videau, H. (Ecole Polytechnique, 75 - Paris (France). Lab. de Physique des Hautes Energies); Hansen, J. D. (Niels Bohr Institutet, Copenhagen (Denmark)); Volte, A. (College de France, 75 - Paris). Phys. Lett., B; 55: No. 2, 245-248(3 Feb 1975).

Results on the partial wave analysis of the $K\pi\pi$ system in the mass interval 1.1 to 1.6 GeV/c^2, in the reaction $K^-p \to K^-\pi^-\pi^+p$ at 3.95 GeV/c are presented. The results are compared to those at higher energies, and certain differences are noted. In particular, very much less of the ρK decay mode of the 1^+SO^+ wave is found. In addition, the relative phase between the $1^+SO^+(K^*\pi)$ and the $2^+D\,1^+(K^*\pi)$ wave was measured. (auth)

4697 MODELS FOR PION PRODUCTION WITH PAIR CORRELATIONS. Mueller, V. F. (Trier-Kaiserslautern Univ., Kaiserslautern (F. R. Germany). Fachbereich Physik). Nucl. Phys., B; 87: No. 2, 318-324(3 Mar 1975).

Two models for the production of particles with internal quantum numbers are investigated. They are based on the leading particle approximation. First a unitary isospin invariant S-operator model is constructed for pion production. Then generalized coherent states for particle-antiparticle pairs are introduced from which a statistical operator is derived. Both approaches imply nonvanishing correlation integrals. (auth)

Strong (Baryon No. = 1)

4698 (COO-3071-137) BAG MODELS OF QUARK CONFINEMENT BASED ON LOCAL FIELD THEORIES. Klein, A.; Krejs, F. R. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 25 Feb 1975. 30p. Dep. NTIS $4.50.

Classical field approximations should be deriveable from appropriate matrix elements of quantum field equations. This correspondence principle was applied to a critical study of several recent bag models of quark confinement based on local field theories of interacting fermions and scalar mesons. These derivations require Hartree and static approximations. The latter appear to be unjustified for the solutions given to date, and doubt is therefore cast, tentatively, on these models. It is indicated that solutions which do not contravene static assumptions may exist, but under conditions which (for quark-antiquark systems) would make them unstable against decay into free scalar mesons. On the technical side, a translationally invariant Hartree or higher approximation may represent a viable alternative to Bethe–Salpeter formulations for bound state problems. (auth)

4699 (ITF-74-164P) THRESHOLD PP AND PB SCATTERINGS IN NONLINEAR CHIRAL SU(3) × SU(3) DYNAMICS WITH MODIFIED MULTIPLET BREAKING. Torich, Z. Z. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The nonlinear chiral SU(3) × SU(3) dynamics (Gürsey exponential parametrization) of pseudoscalar mesons and baryons with modified multiplet symmetry breaking is considered. S- and P-wave lengths of PP and PB scattering are calculated on the basis of the broken Lagrangian. The comparison is carried out with the available experimental data and other theoretical predictions. (auth)

4700 (JINR-E2-8424) THEORETICAL INTERPRETATION OF THE NUCLEON FORM FACTOR DEPENDENCE ON THE MOMENTUM TRANSFER. Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 9p. Dep. NTIS (US Sales Only) $4.00.

A contribution of the nucleon central sphere of radius $R = \hbar/MC$ to its form factor was determined. Allowing for this contribution, in the framework of the vector dominance model, the asymptotic decrease of the form factor was found to be $(\ln|t|/M^2)/t^2$. (auth)

4701 (JINR-P2-8623) ELECTROMAGNETIC EFFECTS IN BARYON-NUCLEAR SCATTERING. Vanzha, A. P.; Lapidus, L. I.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 23p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

It is shown that the electromagnetic effects, connected with particle spin, influence the polarization effects at the elastic charged baryon scattering at small angles inside the Coulomb interference region (in the case when the singularity over the momentum transferred electromagnetic effects can be neglected). The expressions for the polarization P_0 and the Wolfenstein parameter A, are obtained taking into account the nonsingular electromagnetic effects. (auth)

4702 (JINR-P3-8577) FAST ADIABATIC NEUTRON SPIN FLIP. Taran, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Some possible applications of the fast adiabatic spin flip in neutron physics are considered. The equation of the neutron spin motion in a static magnetic field with the constant gradient in the presence of an oscillating field was solved by numerical methods. A quantitative figure of merit for the parameters of these fields for the effective neutron spin reverse is obtained by the method of adiabatic passage through resonance. (auth)

4703 HIGH-ENERGY πN BACKWARD-SCATTERING MODELS AND CONTINUOUS-MOMENT SUM RULES. Peterson, C.; Sollin, L. (Univ. of Lund, Sweden). Nuovo Cim.; 26A: No. 1, 1-15(1 Mar 1975).

High-energy models for πN backward scattering are investigated with respect to consistency with low-energy data using CMSR. As low-energy t-channel input, $\pi\pi$ phase shifts are used below the $K\bar{K}$ threshold and narrow-width approximations for higher meson poles.

Real parts are restricted to appear in the s-channel physical region. A pole model with a double zero in N_α and a "geometrical delta" model reproduce the data on $\pi N \to N\pi$ and $\bar{N}N \to \pi\pi$, when the parameters are determined by CMSR. (auth)

4704 πN BACKWARD SCATTERING, LEADING LOGARITHMIC APPROXIMATION. Perlovskii, L. I.; Kheifets, E. P. (Novosibirsk State Univ., USSR). Yadern. Fiz.; 21: No. 2, 446-455 (Feb 1975). (In Russian).

For the πN backward scattering at high energies (baryon trajectories) leading logarithmic asymptotics for all perturbative orders are summed up in the γ_5 theory. The obtained representation for the amplitude has fixed root branch points in the j plane. (auth)

4705 ESTIMATES OF CROSS SECTIONS FOR DOUBLE-REGGEON PROCESSES. Azimov, Ya. I.; Levin, E. M.; Ryskin, M. G.; Khoze, V. A. (Leningrad Inst. of Nuclear Physics). Yadern. Fiz.; 21: No. 2, 413-425(Feb 1975). (In Russian).

Properties are discussed and values of the cross sections are estimated for double-pomeron processes. The main attention is paid to the reactions $pp \to p\,(\pi\pi)^0 p$ and $\pi^\pm p \to \pi^\pm\,(\pi\pi)^0 p$, that were studied experimentally. It is shown that the accuracy attained in the experiments is near the expected value of the double-pomeron contribution. Contributions from other double-reggeon processes and the background due to the conventional diffractive dissociation are also considered. (auth)

4706 ELASTIC πN SCATTERING AND CHARGE EXCHANGE IN MODIFIED QUASIEICONAL MODEL. Eremyan, Sh. S. (Erevan Physical Inst.). Yadern. Fiz.; 21: No. 2, 373-385(Feb 1975). (In Russian).

The elastic $\pi^\pm p$ scattering data and the $\pi^- p$ charge exchange data are analyzed in the framework of the complex momentum method taking into account the moving branch points with the shower amplification coefficients depending on momentum transfer. It is shown that to describe the data at $|t| > 0.7$ $(GeV/c)^2$ it is necessary to consider the momentum transfer dependence of the residue functions. A good agreement with the experiment is achieved in the region $0 \le t \le 2(GeV/c)^2$. (auth)

4707 ACCOUNT OF RECOIL AND RESCATTERING FOR πd SCATTERING IN THE RESONANCE ENERGY REGION. Braun, M. A.; Senyushkin, V. B. (Leningrad State Univ.). Yadern. Fiz.; 21: No. 2, 279-287(Feb 1975). (In Russian).

Corrections to the πd scattering amplitude due to account of the pion rescattering and the recoil near the Δ(1236) resonance are considered. With account of these corrections the πd-scattering total cross section is calculated in the pion kinetic energy interval 100 to 200 MeV, as well as the differential cross section at the pion energy of 180 MeV. (auth)

4708 N* RESONANCE PARAMETERS AND K-MATRIX FITS TO THE REACTIONS $\pi N \to \Delta\pi + \rho N + \epsilon N$. Longacre, R. S.; Rosenfeld, A. H.; Lasinski, T.; Smadja, G. (California Univ., Berkeley (USA). Dept. of Physics); Cashmore, R. J.; Leith, D. W. G. S. (Stanford Linear Accelerator Center, Calif. (USA)). Phys. Lett., B; 55: No. 4, 415-419(3 Mar 1975).

From a partial wave analysis of the reaction $\pi N \to \pi\pi N$ 50 couplings and partial widths are extracted for N* resonances decaying into $\Delta\pi$, ρN and ϵN. Three different methods of determining the resonance parameters are compared. The signs of the $\pi\Delta$ couplings are found to be consistent with the predictions of 1-broken $SU(6)_w$, if one assigns $P'_{11}(1415)$, $P''_{11}(1730)$ and $P_{33}(1700)$ to [56, L = 0^+] supermultiplets. The signs of the ρN couplings are inconsistent with $SU(6)_w$ symmetry in its 1-broken form, but in good agreement with the observed photon couplings. (auth)

4709 BOUNDS ON COUPLING CONSTANTS PROVIDED BY THE KNOWLEDGE OF MODULI AND ZEROS OF FORWARD SCATTERING AMPLITUDES. Dumbrajs, O. V.; Staszel, M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Nucl. Phys., B; 88: No. 1, 52-60(17 Mar 1975).

A new method of analyzing experimental data on forward scattering amplitudes is used to obtain a set of strong correlations between the values of coupling constants and positrons of zeros of the amplitudes. The method reveals the importance and present insufficiency of knowledge of the locations of zeros. In particular, for the $\pi^\pm p$ forward scattering amplitude the domain necessarily free from zero was found in the energy plane. In the case of the K^+p forward scattering the method provides upper bounds on the coupling constants $g^2_{KN\Lambda}$, $g^2_{KN\Sigma}$ and a relation between them. Moreover, a region was found where the location of a real zero is forbidden. (auth)

4710 ON THE MEASURABILITY OF LONG RANGE VAN DER WAALS FORCES BETWEEN PROTONS. Barut, A. O.; Nagel, J. (Colorado Univ., Boulder (USA). Dept. of Physics). Phys. Lett., B; 55: No. 2, 147-148(3 Feb 1975).

The coefficient C of the long range van der Waals potential $V = -C/R^7$ between nucleons is estimated in two different ways and is found to be about six orders of magnitude smaller than the value given recently in Sawada's analysis. Other electromagnetic long range processes are discussed. (auth)

4711 K^+p SCATTERING WITH UNITARY PADE APPROXIMANT. Andrade, S. C. B.; Ferreira, E. (Pontificia Universidade Catolica do Rio de Janeiro (Brazil)); Ye Chang, L. (Universidad Central de Venezuela, Caracas. Departamento de Fisica). Nucl. Phys., B; 87: No. 3, 485-508 (10 Mar 1975).

The K^+p system is studied with the Pade approximants method. From a Lagrangian written in terms of kaon, nucleon, and hyperon fields the [1,1] Pade approximant is evaluated for the $s, p_{\frac{1}{2}}$, and $p_{\frac{3}{2}}$ waves. The results for differential and total cross sections, polarization, and phase shifts are compared with experimental data at low energies and with solutions of phase shift analyses. It is found that the model describes very satisfactorily all the available data on the K^+p interaction at low energies. (auth)

4712 RESONANCE SPINS AND REGGE RESIDUES. Dash, J. W. (Oregon Univ., Eugene (USA). Inst. of Theoretical Science); Jones, S. T. (Alabama University (USA)). Phys. Lett., B; 55: No. 2, 212-216(3 Feb 1975).

The diffractive component of the slopes of elastic differential cross sections at intermediate energies is examined in the context of a strong coupling multiperipheral cluster resonance model. The crucial ingredient is the incorporation of resonance spins. Qualitative agreement with πp, Kp, and pp scattering is obtained. A mechanism whereby s-channel helicity can be approximately conserved in elastic but not in certain quasi-elastic diffractive processes is also conjectured. The problem of the extension to NAL-ISR energies is briefly discussed. (auth)

4713 A COMPARATIVE INVESTIGATION OF LOW MASS $\pi^+\omega$ AND $K^-\omega$ SYSTEMS AT VARIOUS ENERGIES. Otter, G.; Rudolph, G.; Rumpf, K.; Seyfert, H. H.; Sixel, P.; Wieczorek, H. (Technische Hochschule Aachen (F. R. Germany). 3. Physikalisches Inst.); Becker, L.; Kaufmann, H. H. (Deutsche Akademie der Wissenschaften zu Berlin (German Democratic Republic)); Hartmann, R.; Plothow, H. Nucl. Phys., B; 87: No. 2, 189-206 (3 Mar 1975).

A comparison is made of the properties and production mechanism of the $\pi^+\omega$ and $K^-\omega$ systems produced in the reactions $\pi^+p \to \pi^+\omega p$ at 4, 5, 8 and 16 GeV/c and $K^-p \to K^-\omega p$ at 10 and 16 GeV/c. In the $\pi^+\omega$ case a peak is observed at 1.23 GeV (the B meson), while the $K^-\omega$ mass distribution has a threshold enhancement. The cross section of the low mass (<2.0 GeV) $\pi^+\omega$ system falls as p^{-2}_{lab}, while that of the low mass (<2.0 GeV) $K^-\omega$ system is almost constant with energy, indicating diffractive production of the $K^-\omega$ system, but not of the $\pi\omega$ system. Using a modified version of the Illinois partial-wave analysis program, it is found that the $K^-\omega$ system is dominantly produced in the $J^P = 1^+$ state with small contributions of 0^- and 2^+, mainly by natural parity exchange—as is found for reactions such as $K^-p \to (K^-\pi^+\pi^-)p$ which are predominantly diffractive. For the $\pi^+\omega$ system in the B mass region, $J^P = 1^+$ states, produced mainly by natural parity exchange are found; the contributions of 0^-P, 1^-P, 2^-P and 2^+D are consistent with zero. The 1^+D state occurs in the $\pi^+\omega$ case but not in the $K^-\omega$ system, nor in the $K\pi\pi^-$ system produced in the $K^-p \to K\pi\pi p$ reaction. (auth)

4714 THE DERIVATIVE RULE FOR HELICITY-FLIP AMPLITUDES. Barger, V. (Wisconsin Univ., Madison (USA). Dept. of Physics); Phillips, R. J. N. (Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Nucl. Phys., B; 87: No. 2, 221-237(3 Mar 1975).

Consequences of the derivative relation $f_+ = \lambda\partial f_{s+}/\partial\sqrt{-t}$, proposed empirically and also in various models for s-channel helicity amplitudes, are explored. A comparison with $\pi^-p \to \pi^0 n$ charge-exchange data is made, imposing the usual Reffe pole form on f_+. The assumptions are seen to conflict with the s-dependence of the cross section dip and the polarization structure. There are also difficulties with finite energy sum rules and with experimental data on some other reactions. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 4474, 4795, 4808, 5123, and 5139.

4715 (JINR-E1-8495) FOUR-MOMENTUM TRANSFER DISTRIBUTION FOR THE CHARGE RETENTION BREAKUP AT 3.3-Gev/c INCIDENT DEUTERON MOMENTUM. Aladashvili, B. S.; Badelek, B.; Glagolev, V. V.; Lebedev, R. M.; Nassalski, J.; Nioradze, M. S.; Odyniec, G.; Saitov, I. S.; Sandacz, A.; Siemiarczuk, T.; Stepaniak, J.; Strel'tsov, V. N.; Zielinski, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

The dσ/dt differential cross section is studied for the dp → pnp reaction at 3.3 GeV/c deuteron momentum and compared with the Glauber multiple scattering theory. Within the limits of the uncertainties of the existing elementary nucleon-nucleon data, the simple Glauber model calculations with the realistic deuteron form factor give satisfactory agreement with experiment. (auth)

4716 (JINR-E4-8414) DOUBLET S-PHASE SHIFT IN THE nd-SCATTERING BELOW THE DEUTERON BREAK-UP THRESHOLD IN THE INDEPENDENT OF AND LINEAR IN THE NN-INTERACTION RANGE APPROXIMATION. Efimov, V. N.; Tkachenko, E. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 21p. Dep. NTIS (US Sales Only) $4.25.

The integral equations for the S-wave doublet nd-scattering in the independent of and linear in the NN-interaction range approximation are solved using the Kharchenko method of cutting the integral equation kernels. The cut-off parameter is defined through the experimental value of the doublet scattering length. Calculated S-phase shifts in the doublet nd-scattering below the deuteron break-up threshold are in good agreement with experiment and do not depend on the cutting fashion. (auth)

4717 (JINR-P1-8464) π^{-12}C INTERACTIONS AT E_π = 40 GeV AND THE HYPOTHESIS ABOUT HADRON CLUSTERS. Inogamova, T. Ya.; Kalinkin, B. N.; Lyubimov, V. B.; Tuvdendorzh, D.; Shmonin, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The analysis of some characteristics of the interaction of π^--mesons with ^{12}C nucleus at pc = 40 GeV (distributions of fast and slow particle multiplicity, correlations between them, etc.) is presented. The obtained results are in good agreement with the hypothesis of intermediate cluster state realization. (auth)

4718 BEHAVIOR OF MATTER AT SUPERHIGH DENSITY. Canuto, V.; Lodenquai, J. (Nordita, Copenhagen, Denmark). Phys. Rev. D 11: No. 2, 233-244 (15 Jan 1975).

The behavior of matter at densities higher than 10^{16} g/cm^3 is investigated. It is found that little information can be gained from the data on neutron stars, whose properties are essentially determined by the behavior of $p = c_s^2\varepsilon$ in the region $10^{14} \leq \rho = \varepsilon/c^2 \leq 5 \times 10^{15}$ g/cm^3. On the contrary, the study of the properties of the p-p collision in the GeV region seems to provide more stringent conditions. The Landau model is used to analyze data concerning the average multiplicity, the constancy of transverse momenta, and the behavior of the energy per particle. Using a newly derived relation for the hadronic viscosity $\eta \sim T^{1/c_s^2}$ we show that the Landau hydrodynamic model reproduces the same results as the multiperipheral model without the need of any extra hypothesis, if the value $c_s^2 = 1$ is adopted. Once this conclusion is reached, several pion-pion Lagrangians are analyzed and their predictions for c_s^2 investigated. The fundamental assumption of the Landau hydrodynamical model, i.e., the laminar nature of the flow, is also investigated. The result is found that the pion fluid can become turbulent in the later stages of evolution, thus giving rise to eddies or clumps of matter tentatively identified with the clusters found in the p-p scattering. (auth)

4719 TWO-PION CONTRIBUTIONS TO THE NUCLEON-NUCLEON INTERACTION. Gillespie, G. H. La Jolla, San Diego, CA; Univ. of California (1974). 374p. University Microfilms Order No. 75-9482.

Thesis (Ph. D.).

A nucleon-nucleon potential which includes two-pion-exchange contributions is constructed. The potential is non-local and, in general, energy dependent. Uncorrelated two-pion-exchange terms include both N and N* (1236) intermediate states. Correlated two-pion-exchange contributions are included for the pi-pi s- and p-waves. The p-wave contribution is represented by the rho-meson, and the s-wave is treated within the context of the linear sigma-model. This model assures that the low-energy pi-N theorems are satisfied. Additional (three-pion) contributions are included via the eta and omega mesons. Nucleon-nucleon phase shifts are calculated numerically using an energy-independent, but nonlocal, approximation to the potential. Varying the coupling constants to fit the experimental data indicates that the uncorrelated two-pion-exchange contribution, arising from nucleon intermediate states only, provides the majority of the required attraction. N* (1236) contributions are entirely too large for reasonable couplings and the contributions required by the low energy pi-N theorems play no role in the best fit obtained. (Diss. Abstr. Int., B)

4720 MULTIPLICITY CORRELATIONS IN MULTIHADRON REACTIONS. Andersson, B. (Lund Univ. (Sweden). Institutionen foer Teoretisk Fysik med Mekanik); Otterlund, I. (Lund Univ. (Sweden)). Nucl. Phys., B; 88: No. 2, 349-357(24 Mar 1975).

Tests of the correlations between the multiplicity distributions stemming from the different encounters between the incoming proton and the nucleons inside the nucleus in high energy proton-nucleus collisions are devised and compared to experimental results. The results show that large correlations must exist between the individual collisions and throw some doubts on the relevancy of a description based upon the individuality of the different encounters. (auth)

4721 REMARK ON THE PRODUCTION CROSS SECTION OF J PARTICLES IN HADRON-HADRON COLLISIONS ACCORDING TO THE STATISTICAL BOOTSTRAP MODEL. Kripfganz, J.; Ranft, J. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). Phys. Lett., B; 55: No. 3, 301-302(17 Feb 1975).

Heavy J particles decaying into e^+e^- were recently found in p–Be collisions as well as in e^+e^- annihilations, where also the decay into hadrons with a branching ratio of about $\sigma(J \to h)/\sigma(J \to e^+e^-) = 15$ was observed. This letter compares the production of the J(3105) particle with pion production, and gives the predictions of the statistical bootstrap model. (auth)

4722 IS LARGE ANGLE EXCLUSIVE SCATTERING CONTROLLED BY THE HADRONIC RADIUS? Schrempp, B.; Schrempp, F. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 55: No. 3, 303-306 (17 Feb 1975).

It is pointed out that the large angle pp → pp data suggests an exponential behavior in $p_\perp$ modulated by a regular oscillation in $p_\perp$ more naturally than a power law s^{-N}. It is argued that these effects are due to a manifestation of the same geometrical length scale R ~ 1 fermi which is known to control small angle scattering. (auth)

4723 TESTS OF GEOMETRICAL SCALING AND GENERALIZATIONS. Barger, V.; Luthe, J. (Wisconsin Univ., Madison (USA). Dept. of Physics); Phillips, R. J. N. (SEE CODE-5677710 Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Nucl. Phys., B; 88: No. 2, 237-256(24 Mar 1975).

The detailed consequences of geometrical scaling are discussed for the pomeron (suggested by pp scattering results above 200 GeV/c), and the experimental status in pp, πp and Kp scattering is summarized up to the highest available momenta. Possible generalizations of geometrical scaling, that relate reactions with different ratios σ_{el}/σ_t, are investigated, and their predictions compared for πp and Kp scattering; the range $-t > 1$ GeV^2, beyond present measurements, is particularly sensitive. Predictions for Λp and Σp scattering are also made. Some conjectures are offered on possible geometrical scaling for inclusive processes, mediated by pomeron exchange. (auth)

4724 THE PARITY-VIOLATING ASYMMETRY IN PROTON–PROTON SCATTERING. Epstein, G. N. (Oxford Univ. (UK). Dept. of Theoretical Physics). Phys. Lett., B; 55: No. 3, 249-251(17 Feb 1975).

Using dispersion relations it is shown that the parity-violating proton–proton asymmetry depends significantly on the unknown high energy nucleon–nucleon phase shift. (auth)

4725 ONE-BOSON-EXCHANGE MODELS AND REGGE POLES. A Study of Low Energy Nucleon–Nucleon and Hyperon–Nucleon Scattering. Rijken, T. A. Nijmegen, Netherlands; Katholieke Univ. (1975). 260p.

Thesis.

NN and Λp experimental data and the SU(3) classification are reviewed, and the theory of low energy NN and YN interactions (Y is a hyperon) is described and developed in the context of the analytic s-matrix theory using the new strip approximation. A hard-core-one-boson exchange model is described in detail, and the results are displayed for both the NN and YN channels. (NL)

Particle Invariance Principles and Symmetries

General

4726 (IC-75/1) EXCEPTIONAL INTEGER POINTS IN THE REPRESENTATION SPACE OF THE PSEUDO-ORTHOGONAL GROUP 0(2h + 1,1). Dobrev, V.; Petkova, V.; Petrova, S.; Todorov, I. T. (International Centre for Theoretical Physics, Trieste (Italy)). Jan 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The study of elementary representations of 0↑(2h + 1,1),

started previously, is completed. The structure of nondecomposable reducible representations at exceptional integer points is explored. Two discrete series of unitary representations associated with the integer points are singled out. Diagrams of intertwining operators for "quartets" of exceptional representations are presented. The results are applied to fill a gap in the derivation of conformal covariant operator product expansions undertaken previously. (auth)

4727 SPONTANEOUS BREAKING OF DISCRETE SYMMETRIES AND THE SEMICLASSICAL APPROXIMATION. Hietarinta, J. (Institute for Theoretical Physics, State University of N.Y. at Stony Brook, Stony Brook, New York 11794). Phys. Rev. D 11: No. 2, 327-330 (15 Jan 1975).

The generating functional $Z(j) \equiv <0|0>_j$ is evaluated asymptotically as $\hbar \to 0$ with special attention to the existence of several extremal points of the action. We show that $Z(j) \sim N\Sigma_\alpha \exp[(i/\hbar) W_\alpha(j)]$, where α labels the extremal points. Here each W_α has a Taylor expansion in $\hbar$. Some implications and interpretations of this new result are given. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 4547, 4650, 4652, 4851, and 4859.

4728 PRODUCTION OF LEPTONIC PAIRS IN A NEUTRINO BEAM. Two-Particle Correlations. Asratyan, A. E.; Kubantsev, M. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 21: No. 2, 355-359(Feb 1975). (In Russian).

The parity nonconservation effects in the scattering of polarized leptons and antileptons on nucleons are discussed. If the structure of weak neutral currents is known, then observations of those effects could serve to determine the sign of the weak interaction constant. The nonconservation effects are considered in detail for the case when the neutral currents have structure arising in unified theories of weak and electromagnetic interactions. (auth)

4729 THE STRUCTURE OF PARITY VIOLATING STRANGENESS CONSERVING WEAK NON-LEPTONIC AMPLITUDES IN AN ASYMPTOTICALLY FREE THEORY. Altarelli, G.; Ellis, R. K.; Petronzio, R. (Rome Univ. (Italy)); Maiani, L. (Istituto Superiore di Sanita, Rome (Italy)). Nucl. Phys., B; 88: No. 2, 215-236(24 Mar 1975).

The structure of parity violating $\Delta S = 0$ weak nonleptonic amplitudes is studied in a gauge theory of strong, weak and electromagnetic interactions based on the Weinberg-Salam theory with three quartets of fractionally charged quarks. It is shown, that similarly to what happens for $\Delta S = 1$ nonleptonic amplitudes, a definite pattern of enhanced terms emerges. The enhanced operators have isospin zero and one, while isospin-two components are suppressed. The enhancement factors are comparable to those found in the same model for $\Delta S = 1$ transitions and can account for at least a part of the present disagreement between experimental findings and theoretical estimates for the photon polarization in the process $n + p \to d + \gamma$ at thermal energies. (auth)

4730 COINCIDENCE ELECTROPRODUCTION REACTIONS AS A TEST OF NEUTRAL CURRENTS. Korthals-Altes, C. P.; Perrottet, M.; de Rafael, E. (Centre National de la Recherche Scientifique, 13 - Marseille (France). Centre de Physique Theorique). Nucl. Phys., B; 87: No. 3, 527-545(10 Mar 1975).

Possible parity violating effects induced by neutral weak currents in processes of the type lepton + nucleon $\to$ lepton + hadron + hadronic debris are discussed. Rigorous upper bounds to these parity violating observables are derived using general positivity restrictions. (auth)

Applications (Strong)

Refer also to abstracts 4553, 4682, 4690, 4724, 4968, and 5104.

4731 ASYMPTOTIC FREEDOM AND THE "COLOR" GAUGE GROUP. Ma, E. (Department of Physics, University of California, Santa Barbara, California 93106). Phys. Rev. D 11: No. 2, 322-326 (15 Jan 1975).

In the light of a recent discovery by Chang that there exist particular solutions to the renormalization-group equations which may render a field theory asymptotically free even though the general solutions do not, we present a gauge model of superstrong quark interactions based on local SU(2) in which functional conditions are imposed on the coupling constants so that the theory remains asymptotically free despite the complete breakdown of symmetry which occurs by way of the Higgs mechanism. This model is also highly realistic in the sense that it is consistent with the usual quark phenomenology, in addition to providing a clue to the dynamics involved. (auth)

Scattering Theory

Refer also to abstracts 4675, 5145, 5161, 5164, and 5235.

4732 (IC-74-19) FINITE-RANK POTENTIALS IN THE TWO-BODY SCATTERING PROBLEM. Pisent, G. (International Centre for Theoretical Physics, Trieste (Italy)). Mar 1974. 31p. INIS.

The aim of these lectures is a general and — as far as possible — complete outline of the two-body scattering theory in the framework of finite-rank potentials. Several topics particularly important for phenomenological applications – like s-wave separable potentials – are derived as particular cases. Many-channel, finite-rank interaction are also considered which may be of interest if one of the two bodies – i.e., the target – is a particle with internal structure. (auth)

4733 (ITF-74-133P) STATIONARY VALUES OF IMAGINARY PART OF THE AMPLITUDE IN THE DIFFRACTION CONE REGION. Gulyamov, U. G.; Arushanov, G. G.; Sofienko, L. A.; Ismatov, E. I. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

From the amplitude unitarity condition and its decomposibility into partial waves the upper and lower bounds on the imaginary part of the elastic scattering amplitude are obtained at large energies in the diffraction cone region. It is shown that when in addition to positivity of partial values the upper bounds are taken into account it allows one to improve significantly the result of Singhand Roy. The analogous method is also applied to obtain the stationary values of the Van Hove overlap functions. (auth)

4734 (ITF-74-152P) RENORMALIZED AMPLITUDES IN THE QUANTUM ELECTRODYNAMICS. Chudinovich, I. Yu. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 32p. (In Russian). Dep. NTIS (US Sales Only) $4.75.

The cancellation procedure in quantum electrodynamics with "cancellation centers" at the origin is studied. The existence of renormalized Feynman amplitudes corresponding to unflatten spinor and electromagnetic fields is proved. (auth)

4735 (JINR-P2-8648) CHOICE OF THE VARIABLES FOR THE TWO-PARTICLE PROCESS AMPLITUDES. Garsevanishvili, V. R. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 11p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The problem on choosing the variables for the two-particle process amplitudes is considered as well as a new analyticity property appearing in this case. The investigation has been performed at the Laboratory of Theoretical Physics, JINR. (auth)

4736 (LBL-3698) MICROLOCAL STUDY OF S-MATRIX SINGULARITY STRUCTURE. Kawai, T.; Stapp, H. P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1975. Contract W-7405-eng-48. 14p. (CONF-750125-1). Dep. NTIS $4.00.

Support is adduced for two related conjectures of simplicity of the analytic structure of the S-matrix and related function; namely, Sato's conjecture that the S-matrix is a solution of a maximally over-determined system of pseudo-differential equations, and the conjecture that the singularity spectrum of any bubble diagram function has the conormal structure with respect to a canonical decomposition of the solutions of the relevant Landau equations. This latter conjecture eliminates the open sets of allowed singularities that existing procedures permit. (auth)

4737 (RL-75-036) HIGH ENERGY FIXED ANGLE SCATTERING INVOLVING A REGGEON. Scott, D. M. (Science Research Council, Chilton (UK). Rutherford Lab.). Feb 1975. 27p. (T-109). Dep. NTIS (US Sales Only) $4.50.

A high energy amplitude with single particle production is investigated in a single Regge limit in which the four particle amplitude with the Reggeon as one of the external particles is evaluated in a fixed angle, high energy limit. Constituent models suggest that asymptotically there is no azimuthal dependence, and also that the fixed angle Reggeon amplitude has power law behavior with energy. This power is discussed. (auth)

4738 (RL-75-039) PHASE SHIFT ANALYSIS OF ONE DIMENSIONAL SCATTERING. Formanek, J. (Science Research Council, Chilton (UK). Rutherford Lab.). Mar 1975. 8p. (T-110). Dep. NTIS (US Sales Only) $4.00.

The problem of phase shift analysis of one dimensional scattering is investigated. It is shown that conditions required by Eberly are not sufficient for guaranteeing parametrization of scattering amplitude by phase shifts. The weak point of Eberly's reasoning is indicated, and the missing substantial condition is specified. (auth)

4739 (RL-75-041) MULTIPLICITY BOOTSTRAP AND THE DUAL UNITARITY EQUATION. Dias de Deus, J. (Science Research Council, Chilton (UK). Rutherford Lab.). Mar 1975. 13p. (T-111). Dep. NTIS (US Sales Only) $4.00.

In some approximation, the dual unitarity equation is treated as a bootstrap equation for the Pomeron amplitude and the n-particle production cross sections. The solution of the bootstrap requires $\alpha_P = 1$ for the Pomeron intercept independent of the Reggeon trajectory. Agreement with multiplicity data strongly constrains the Reggeon intercept α_R to be very close to $\frac{1}{2}$. (auth)

4740 (RL-75-042) LOCAL LOOP DOMINANCE IN THE DUAL UNITARITY SCHEME. Dias de Deus, J.; Uschersohn, I. (Science Research Council, Chilton (UK). Rutherford Lab.). Mar 1975. 22p. (T-112). Dep. NTIS (US Sales Only) $4.25.

The unitarity equation in the dual approach can be written as a sum over Reggeon loop diagrams. It is assumed that in some definite regions in energy, only one diagram, with a definite number of loops dominates the sum. As consequences SU(N) symmetry for coupling constants, Gell-Mann Okubo formulas for mass breaking, and exchange degeneracy for Reggeon trajectories are obtained. Also relations are derived connecting the Pomeron and Reggeon intercepts with quantities referring to production of clusters. (auth)

4741 SCATTERING BY POTENTIALS WITH COULOMB TAILS. Semon, M. D.; Taylor, J. R. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 26A: No. 1, 48-58(1 Mar 1975).

An earlier study of the Coulomb partial-wave series and of the connection between screened and unscreened Coulomb potentials is extended to potentials made up of a Coulomb potential plus an arbitrary short-range part $V^{s.r.}(r)$. The partial-wave series for the contribution of $V^{s.r.}$ is shown to converge pointwise, for all θ, provided $V^{s.r.}$ is $O(r^{-3-\delta})$ as $r \to \infty$. (auth)

4742 CROSSING IN $2 \to 3$ PARTIAL-WAVE AMPLITUDES. Klink, W.H. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). Phys. Rev. D 11: No. 2, 361-365 (15 Jan 1975).

Crossing in $2 \to 3$ reactions is investigated, and it is shown that by using canonical variables we can express crossing in a particularly simple form. (auth)

4743 SCATTERING INTO CONES AND FLUX ACROSS SURFACES. Combes, J.; Newton, R.G.; Shtokhamer, R. (Physics Department, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 11: No. 2, 366-372 (15 Jan 1975).

The relation between the physical meaning of a nonrelativistic N-particle flux and its mathematical representation in quantum mechanics is discussed. We prove a theorem that equates the probability of finding an N-fragment system in the distant future in a given cone with the total probability that the fragments cross a distant surface subtended by the cone. Together with the scattering-into-cones theorem this result proves that the usually calculated number of fragments whose momenta in the distant future lie in a given cone is equal to the total counted number of fragments that, at any time, cross a subtended distant surface. It thus adds to both physically and mathematically cleaner underpinnings of scattering theory. (auth)

4744 DELBRUECK SCATTERING. Papatzacos, P.; Mork, K. Arkf. Fys. Seminar Trondheim; No. 3, 82p(1975).

A review of the various calculations of the Delbrueck scattering amplitude is presented. This is followed by some general discussion on the elastic scattering of photons by heavy atoms and finally by a review of experiments performed together with a comparison of these with the calculations. (JIW)

4745 ON THE STRUCTURE FUNCTION IN THE SCALING LAW FOR PARTIAL-WAVE AMPLITUDES. Common, A. K. (Kent Univ., Canterbury (UK)). Phys. Lett., B; 55: No. 3, 318-320(17 Feb 1975).

An expression is obtained for the structure function $\beta(\chi)$ occurring in a scaling law for s-channel partial wave amplitudes which had been recently derived from t-channel unitarity at threshold. (auth)

4746 ALL POSSIBLE GENERATORS OF SUPERSYMMETRIES OF THE S-MATRIX. Haag, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Lopuszanski, J. T. (Wroclaw Univ. (Poland). Instytut Fyziki Teoretycznej); Sohnius, M. (Karlsruhe Univ. (TH) (F. R. Germany)). Nucl. Phys., B; 88: No. 2, 257-274(24 Mar 1975).

A generator of a symmetry or supersymmetry of the S-matrix has to have three simple properties. Starting from these properties one can give a complete analysis of the possible structure of the pseudo Lie algebra of these generators. In a theory with nonvanishing masses one finds that the only extension of previously known relations is the possible appearance of "central charges" as anticommutators of Fermi charges. In the massless case (disregarding infrared problems and symmetry breaking) the Fermi charges may generate the conformal group together with a unitary internal symmetry group. (auth)

4747 AMBIGUITIES IN PHASE-SHIFT ANALYSIS. de Roo, M. Groningen, Netherlands; Rijksuniversiteit Groningen (1974). 104p.

Thesis.

It is shown that, even in the idealized situation where angular distributions are known without experimental uncertainties for all scattering angles, there are serious ambiguities in phase-shift analysis. Methods for the construction of discrete and continuum ambiguities are presented; and these methods, applied to the case of $\alpha\alpha$ scattering. The problem of Coulomb effects is discussed. (NL)

4748 ANALYTICAL PROPERTIES OF THE FORWARD ELASTIC SCATTERING AMPLITUDES FOLLOWING FROM MICROCAUSALITY. Geshkenbein, B. V. (Institute for Theoretical and Experimental Physics, Moscow); Komech, A. I. (Moskovskij Gosudarstvennyj Univ. (USSR)). Phys. Lett., B; 55: No. 2, 192-194(3 Feb 1975).

The forward elastic scattering amplitudes $T_i(\nu,q^2)$, $(i = 1,2)$ of the virtual photon with the mass q^2 are considered in variables σ and ϕ where σ and ϕ are related to q^2 and ν by the formulas $q^2 = \exp(2\sigma)$ and $\nu = \exp(\sigma)\,\mathrm{ch}\phi$. It was proved that microcausality requirement implies the analyticity of amplitudes in the tube region $|\mathrm{Im}\,\sigma + \pi/2| + |\mathrm{Im}\,\phi| < \pi/2$ as a function of both complex variables σ and ϕ. Formulas are obtained expressing amplitudes $T_i(\nu,q^2)$ at arbitrary ν and q^2 through functions $W_i^{(-)}(\nu,q^2)$ describing the electroproduction process $-2\nu < q^2 < 0$. (auth)

4749 QUANTIZATION OF RELATIVISTIC SYSTEMS WITH CONSTRAINTS. Fradkin, E. S. (AN SSSR, Moscow. Fizicheskij Inst.); Vilkoviskii, G. A. (Gosudarstvennyj Komitet Standartov Soveta Ministrov SSSR, Moscow). Phys. Lett., B; 55: No. 2, 224-226(3 Feb 1975).

The general dynamical system with constraints is quantized, and the S-matrix is constructed in the most general class of gauges including relativistic ones. In the case when constraints do not form a group a new type of additional diagrams arises securing unitarity of the theory: the four-fermion interaction of ghost fields. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

4750 TWO-FLUID HYDRODYNAMIC DESCRIPTION OF ORDERED SYSTEMS. Enz, C.P. (Département de Physique Théorique, Université de Genève, 1211 Geneva 4, Switzerland). Rev. Mod. Phys. 46: No. 4, 705-753 (Oct 1974).

A unified description of systems with a condensed phase in terms of hydrodynamic equations of motion is given. These equations are of two kinds: First, those equations obeyed by the thermal excitations (the "first fluid") typically are local conservation equations of mass, energy and momentum. Second, the equation obeyed by the condensed phase (the "second fluid") is an equation of motion related to the order parameter of the broken symmetry. These equations are established on phenomenological grounds making use of irreversible thermodynamics. The eigenmodes of the linearized form of these equations, typically first and second sound, are discussed in particular with respect to their manifestation in inelastic light and neutron scattering. The systems considered are homogeneous superfluids, superconductors, dielectric crystals and magnetic systems. Except for superfluid ^{4}He the critical behavior at the phase transition to the ordered state is not systematically discussed. (auth)

4751 OBSERVATION OF A PROFILE ON A SUPERFLUID HELIUM FILM ON A ROTATING SUBSTRATE. Vittoratos, E.; Meincke, P.P.M. (Department of Physics, University of Toronto, Toronto, Canada). Phys. Rev. Lett. 34: No. 13, 796-799 (31 Mar 1975).

Simultaneous measurements of the thickness at two locations of a He II film adsorbed on a rotating substrate have been made. From the thickness difference we deduce that for $T > 2.1$ K the film has a solid-body velocity field, whereas for $T = 1.23$ K the velocity is zero until the linear velocity of the substrate exceeds the translational critical velocity of the film. (auth)

4752 POSITIVE-ION TRAPPING ON VORTEX LINES IN ROTATING He II. Williams, G.A.; DeConde, K.; Packard, R.E. (Department of Physics, University of California, Berkeley, California 94720). Phys. Rev. Lett. 34: No. 15, 924-926 (14 Apr 1975).

The direct trapping of positive He ions on quantized vortex lines in rotating He II has been observed at temperatures below 0.7 K. Trapping lifetimes have been measured between 0.1 and 0.7 K, and agree with models of thermal escape and charge loss from vortex motion. An ion radius of 7.7 ± 0.1 Å is found. (auth)

4753 THERMAL RELAXATION IN LIQUID ^{3}He/^{4}He MIXTURES NEAR THE TRICRITICAL POINT. Islander, S. T.; Loponen, M. T. (Helsinki Univ. of Technology, Otaniemi (Finland)). Phys. Lett., A; 51: No. 3, 157-158 (24 Feb 1975).

Very long relaxation times τ were observed in earlier specific heat measurements on liquid ^{3}He/^{4}He mixtures in two-phase-states near the tricritical temperature T_0. It appears that $1/\tau \propto (T_0 - T)$. (auth)

Superconductivity

Refer also to abstracts 3897, 3971, 3980, 3981, 3994, 4035, 4038, 4042–4045, 4051, 4057, 4065, 4066, and 4750.

4754 (AED-CONF-74-615-001) EXCITON MECHANISM OF SUPERCONDUCTIVITY. Little, W. A. (Stanford Univ., Calif. (USA). Dept. of Physics). 1974. 10p. INIS.

From NATO-ASI conference on low dimensional cooperative phenomena and the possibility of high-temperature superconductivity; Starnberg, F. R. Germany (3 Sep 1974).

In the field of superconductivity theory the scattering of two electrons, k and k*, with momentum transfer q; the form of net electron–electron interaction due to screened Coulomb interaction plus phonon-mediated attraction; and the BCS approximation to the net interaction; and a model excitonic superconductor (a Pt complex of phenanthroline) are treated. (GE)

4755 THE ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS. Tinkham, M. (Department of Physics and Division of Engineering and Applied Physics, Harvard University, Cambridge, Massachusetts 02138). Rev. Mod. Phys. 46: No. 4, 587-596 (Oct 1974).

The London–Ginzburg–Landau concept of superconductivity as a macroscopic quantum state is reviewed. Experimental measurements are then discussed of resistance below T_c, and of enhanced diamagnetism above T_c, both caused by thermodynamic fluctuations away from the Ginzburg–Landau state of lowest free energy. Next, the limitations on superconductivity at nonzero frequencies are reviewed: normal electron dissipation $\propto \omega^2$, and strong absorption above the energy gap frequency. Sum rule arguments relate the superfluid response at low frequencies to the gap; effects of strong electron–phonon coupling are also found. Finally, results of recent work on the resistive state of superconducting filaments above the critical current are summarized. (auth)

4756 ELECTROMAGNETIC THEORY FOR FILAMENTARY SUPERCONDUCTORS. Carr, W.J. Jr. (Westinghouse Research Laboratories, Pittsburgh, Pennsylvania 15235). Phys. Rev. B 11: No. 4, 1547-1554 (15 Feb 1975).

It is shown that a multifilament superconductor, made up of a bundle of twisted filaments embedded in a normal matrix, can be treated as a new state of matter with anisotropic electrical and magnetic properties. Macroscopic electromagnetic field vectors, which satisfy Maxwell's equations, are defined in terms of averages over the "microscopic" fields. However, the sources for the field, i.e., the current and charge densities and the magnetization and polarization, differ in some respects from those for ordinary matter. In particular, since the elementary magnetic dipole moments are distributed along lines rather than located at fixed points, the definition of the magnetization transverse to the filaments differs by a factor of 2 from that for ordinary matter, and the definition of the macroscopic current density is also slightly modified. Constitutive relationships among the field vectors in terms of permeabilities, dielectric constants, and conductivities are examined in the limits of strong and weak fields. (auth)

4757 COLLECTIVE OSCILLATIONS IN A DIRTY SUPERCONDUCTOR. Schmid, A.; Schön, G. (Institut für Physik, Universität Dortmund, 46 Dortmund-Eicklinghofen, Germany). Phys. Rev. Lett. 34: No. 15, 941-943 (14 Apr 1975).

Recent observations of propagating order-parameter collective modes in a dirty superconductor are explained on the basis of a microscopic theory developed previously by the authors. It is shown how approximate charge neutrality of the metal is maintained in these modes. (auth)

4758 CRITICAL FLUCTUATIONS OF A TYPE-II SUPERCONDUCTOR IN A MAGNETIC FIELD. Thouless, D.J. (Department of Mathematical Physics, University of Birmingham, Birmingham B15 2TT, England). Phys. Rev. Lett. 34: No. 15, 946-949 (14 Apr 1975).

Ginzburg's theory of critical fluctuations is used to calculate the specific heat of a type-II superconductor in a magnetic field near the upper critical field. A scaling law for the specific heat is found, and the scaling temperature is given in terms of measurable quantities. Some distance from T_c the fluctuation contribution is proportional to $|T - T_c|^{-3/2}$, with known coefficients. The dependence on k is explored. The diamagnetic susceptibility should have the same temperature dependence as the specific heat. (auth)

4759 RESPONSE OF A PURE SUPERCONDUCTOR TO A SLOWLY VARYING PERTURBATION. Aronov, A.G.; Gurevich, V.L. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). Sov. Phys.–Solid State 16: No. 9, 1722-1726 (Mar 1975).

A system of equations is derived for the response of a pure superconductor to external perturbations which vary slowly in time and are slightly inhomogeneous spatially. The system includes, in addition to the Maxwell equations, an equation for the superconducting gap, a kinetic equation for the distribution function of normal excitations of the superconductor, and a continuity equation for the electron density. In the case of a superconductor the last equation does not follow from the kinetic equation for the excitations; it is independent of the kinetic equation. The kinetic equation is derived by the Keldysh diagram technique. The H theorem and the law of energy conservation in the superconductor are derived from the kinetic equation. The kinetic coefficients calculated from the kinetic equation satisfy the Onsager relation. (auth)

4760 TRANSPORT PHENOMENA IN SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Gasparyan, R.A.; Kresin, V.Z. (Moscow State Correspondence Pedagogical Institute). Sov. Phys.–Solid State 16: No. 9, 1660-1665 (Mar 1975).

A study is made of the electron and lattice thermal conductivities and of the absorption of ultrasonic waves in superconductors containing magnetic impurities. The transport coefficients are calculated by the generalized Bogolyubov u, v transformations. Special attention is paid to the "gapless" superconductivity range. The case of low concentrations is also discussed. The temperature and concentration dependences of the transport coefficients are calculated and the possibility of their experimental observation is analyzed. (auth)

PHYSICS (NUCLEAR)

4761 (CONF-731229-P16A) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, BANGALORE, DECEMBER 27–31, 1973. Volume 16A. Invited Talks. (Indian Inst. of Science, Bangalore). 1973. 166p.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

This volume contains the program for the entire meeting plus all but one of the invited papers presented. Separate abstracts were prepared for seven of the papers; the remaining two, Ising model and phase transition and Soft-mode phase transitions, were not within the subject scope of NSA. (RWR)

For abstracts of individual papers see: 2953, 3409, 3445, 4877, 5062, 5100, and 5101.

4762 (NEANDC(E)-161U) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EUROPEAN COMMUNITY, JANUARY 1–DECEMBER 31, 1973. (Nuclear Energy Agency, 75, Paris (France). Nuclear Data Committee). Aug 1974. 249p. Dep. NTIS (US Sales Only) $15.50.

Brief reports are given on nuclear physics research from 24 sources. A number of the reports contain a significant amount of data. The nature of the sources is such that one may assume that completed work will be reported in the usual channels. (RWR)

4763 (ORNL-TM-4885) REPORT TO THE U. S. NUCLEAR DATA COMMITTEE. Perey, F. G. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 37p. Dep. NTIS $5.00.

This is a collection of recent, not generally publicized, cross-section work done at ORNL and recent papers which have been submitted for publication. This report is prepared for the USNDC and includes only material which the author thinks might be of interest to the USNDC Subcommittee members. The memo covers the period of time since the last USNDC meeting. (3 figures, 1 table) (auth)

For titles of selected papers see: 4822, 4975, 5012, 5038, and 5065.

4764 (TUNL-13) TRIANGLE UNIVERSITIES NUCLEAR LABORATORY SEMIANNUAL REPORT, 31 DECEMBER 1974. Tilley, D. R.; Mitchell, G. E.; Shafroth, S. M.; Thompson, W. J.; Newson, H. W.; Way, K. (Triangle Universities Nuclear Lab., Durham, N. C. (USA)). 1975. 59p. Dep. NTIS $6.00.

Research activities are summarized. One portion of this report is abstracted separately. (CES)

For a title of an individual paper see: 4911.

Neutron Interactions with Matter

Refer also to abstracts 3530–3532, 5080, and 5205.

4765 (CEA-N-1700, pp 244) FISSION STUDY NEAR THE THRESHOLD. Blons, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Preliminary experiments show that the fission cross section study is feasible in the MeV region with a good resolution. (auth)

4766 (CEA-N-1700, pp 245-246) ^{237}Np FISSION BARRIER. Paya, D.; Plattard, S. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The one-dimension fission barrier parameters of ^{237}Np have been deduced from experimental results although the presence of two kinds of intermediate structures different in size is not explained in the framework of such a barrier. (auth)

4767 (JINR-D3-7991) II INTERNATIONAL SCHOOL ON NEUTRON PHYSICS, ALUSHTA, USSR, APRIL 2–19, 1974. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1974. 552p. (In Russian and English). (CONF-740419-).

The volume contains the proceedings of the Neutron Physics School. The papers collected are devoted to the study of the violations of space and time parities in neutron reactions and to investigations with neutrons of the structure of highly excited nuclear states and of dynamics of nuclear processes. One of the sections of the collection concerns the application of neutrons to the structure analysis of molecules and crystals and to investigations of magnetic properties of the substance. It also concerns the new branch of neutron physics — the first steps in neutron molecular biology. Much attention is paid to ultracold neutrons and the possibilities of their use in studying the fundamental properties of the neutron. Separate abstracts are included for 17 of the papers. Two others have already been cited in NSA as abstracts 30:11579 and 30:12108. (auth)

For abstracts of individual papers see: 3579, 4203, 4553, 4554, 4768–4770, 4790, 4968–4972, and 5104–5107.

4768 (JINR-D3-7991, pp 7-18) STORAGE OF ULTRACOLD NEUTRONS. Lushchikov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The factors and processes limiting the storage time of ultracold neutrons ($E < 10^{-7}$ eV) are theoretically evaluated. (1 table) (JSR)

4769 (JINR-D3-7991, pp 19-41) NEUTRON OPTICS AND ULTRACOLD NEUTRONS. Frank, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The optical properties of ultracold neutrons and, to some extent, very cold neutrons ($E < 10^{-4}$ eV), are analyzed on the basis of an examination of the mean potential affecting the neutron in the medium and on the basis of the refraction of neutron waves in a manner analogous to that used in light optics. The optical analogy and the singularities of the dispersion of the neutron wave are considered first. The equations for the refraction of very cold neutrons and ultracold neutrons are derived. Reflection and transmission of the neutron wave are analyzed. The anomalous absorption of ultracold neutrons is discussed. (JSR)

4770 (JINR-D3-7991, pp 42-90) VERY COLD NEUTRONS: A NEW TOOL IN CONDENSED MATTER RESEARCH. Steyerl, A. (Technische Univ., Munich). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

Work with very cold neutrons (VCN) at the FRM reactor, Munich, since the late 1960's is discussed. Much of this work was directed toward applications of VCN in solid state physics. Very cold neutrons are defined to be those with energies below $\sim 10^{-4}$ eV or ~1 K. First, the production of very cold neutrons by a vertical VCN guide tube and a neutron turbine is explained, the latter being considered in some detail. Then applications of very cold neutrons are examined. These include nuclear capture cross sections, elastic VCN scattering on inhomogeneities in solids, quasi-elastic critical scattering of VCN, and the investigation of thin films by perpendicular VCN transmission; deviation from the Born approximation is also discussed. Finally, containment experiments and the related special properties of VCN are treated. (25 figures) (RWR)

4771 (JINR-E4-8404) STORAGE OF ULTRACOLD NEUTRONS IN MAGNETIC TRAPS. Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

The storage of ultracold neutrons (UCN) in the hexapole magnetic field is considered. The storage time estimates are obtained and the influence of the gravitational field is taken into account. (auth)

4772 (JINR-P4-8253) INFLUENCE OF MAGNETIC FIELD INHOMOGENEITIES ON THE SPONTANEOUS AND RESONANCE DEPOLARIZATION OF ULTRACOLD NEUTRONS. Efimov, V. N.; Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 21p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The problem of ultracold neutron (UCN) depolarization induced by the magnetic field inhomogeneities has been considered. The estimates have been made of the tolerable inhomogeneities at a given accuracy of the neutron electrical dipole moment measurement by the separate field method using UCN. (auth)

4773 (STI/PUB-371) NEUTRON STANDARD REFERENCE DATA. Panel Proceedings Series. Proceedings of a Panel held in Vienna, Austria, November 20–24, 1972. (International Atomic Energy Agency, Vienna (Austria)). Dec 1974. 381p. (In Russian and English). (CONF-721127-). IAEA $20.00.

Various topics in the field of neutron standard reference data are discussed in a collection of 31 papers. (SDF)

For abstracts of individual papers see: 3528–3532, 4778–4780, 4793, 4794, 4837–4841, 4977, 5043, and 5068–5081.

4774 (UCRL-76628) COMPARISON OF DOPPLER BROADENING METHOD. Cullen, D. E.; Weisbin, C. R.; Wright, R. Q.; White, J. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Mar 1975. 12p. (CONF-750303-54). Dep. NTIS $4.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

The Doppler broadening equation is solved by solving the analogous diffusion equation with spherical symmetry replacing (velocity, temperature) with (space, time). SIGMA 1 (exact), PSI-CHI, and TEMPO methods for calculating cross sections are compared. Simple Breit–Wigner line shape, low energy cross sections, and ^{235}U and ^{239}Pu self shielding are calculated as examples. (6 figures) (SDF)

4775 (WANL-TME-1946) PROGRESS REPORT ON GENERATION OF A NEW PHOTON PRODUCTION LIBRARY. Fody, S. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1969. 119p. Dep. NTIS $9.00.

The effect of new neutron induced photon production work, both experimental and theoretical, on shielding calculations is discussed. In particular, the available results are converted into a form that allows direct comparison with the contents of the current WANL POINT library. Such comparison indicates significant differences, but it is emphasized that much of the data used in the present work is preliminary, the final values are becoming available only now or in the near future. The need for incorporating these final values into a new shielding library is discussed and the often repeated point is made again: eventually all evaluated photon production data should be given in the form of a special file in ENDF and specific libraries should be generated by specific codes all reading this file. An example of such a file for natural iron is given. (auth)

4776 (WANL-TME-1965) NEW CROSS SECTIONS FOR THE GAMB1T LIBRARY. Tapes FSGAM24 and CGB1T11. Collier, G.; Fody, S. A.; Gibson, G.; Moran, L. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Oct 1969. 61p. Dep. NTIS $6.25.

The GAMB1T cross section library tapes that have been in use for design calculations are GWGAM8 (fast range) plus CGB1T7 and CGGAS7 (thermal range). The new libraries FSGAM24 (RD1, RD2), CGB1T11, and CGGAS11 contain cross sections for many additional isotopes. These new cross sections are identified and reference is made to their origin. In addition, the generation of cross sections for several isotopes that have not been documented elsewhere are described in detail. A table of source spectrum identification numbers is also given since a new source spectrum for ^{235}U has been added. The new libraries are designed for use with the second version of GAMB1T. (24 figures, 4 tables) (SDF)

4777 (WANL-TME-2690) NEW CROSS SECTIONS FOR THE GAMB1T LIBRARY. Fody, S. A.; Gibson, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1970. 30p. Dep. NTIS $4.50.

The additions and alterations described have been made to tapes FSGAM24 and CGB1T11 of the GAMB1T library at WANL. Additions include a complete set of cross sections for the six hafnium isotopes, 200K scattering kernels for beryllium and carbon, 100K scattering kernel for carbon, and a second set of ^{235}U cross sections that includes resonance parameters in the 61.4–167 eV energy range. Zirconium elastic scattering matrices have been changed to include resonance scattering, the estimated gamma widths of ^{91}Zr resonances have been changed from 0.30 to 0.21 eV, and the ^{135}Xe absorption and scattering cross sections have been augmented. (13 tables) (SDF)

4778 SUMMARIES OF PRESENT AND PLANNED WORK ON NEUTRON STANDARDS IN VARIOUS COUNTRIES AND RELATIONSHIP TO NATIONAL NUCLEAR ENERGY PROGRAMS. pp 1-32 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

A survey of current and planned activities in the neutron standard data field in the United States, Australia, Germany, Japan, Sweden, France, Belgium and the United Kingdom is presented. (SDF)

4779 INTERNATIONAL INTERCOMPARISON OF FAST NEUTRON FLUX DENSITY SPONSORED BY BUREAU INTERNATIONAL DES POIDS ET MESURES. Axton, E. J. (National Physical Lab., Teddington, Eng.). pp 37-40 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

An international intercomparison of fast neutron flux density has been undertaken at nine laboratories under coordination by the Bureau International des Poids et Mesures. Neutron energies and transfer instruments related for the intercomparison are discussed briefly. (2 tables) (auth)

4780 SUMMARIES, CONCLUSIONS, AND RECOMMENDATIONS. pp 351-366 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

A summary of methods and techniques of neutron flux measurements, light element standards, and fission and capture standards is presented. Recommendations for further work are offered. (1 table, 1 figure, 41 references) (SDF)

4781 USE OF JACOBI POLYNOMIALS IN MONO-ENERGETIC TRANSPORT THEORY. II. De Corte, L. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Atomkernenergie; 24: No. 4, 266-270(1974).

2 figs.; 7 refs. Part of a thesis.

From the asymptotic eigenvalue of a polynomial expansion of the solution of the mono-energetic Boltzmann equation (in plane geometry with isotropic scattering) a criterion for a physically justified approximation has been derived by Kofink. The region of absorption where the physical requirements are fulfilled is larger for smaller and negative values of the parameter of the Gegenbauer polynomial system. In first approximation and depending on the cases of weak or strong absorption respectively, Legendre polynomials or systems with a negative parameter show the smallest deviation from the exact inverse asymptotic eigenvalue. (auth)

4782 DOUBLE JACOBI POLYNOMIAL SOLUTION OF BOLTZMANN'S TRANSPORT EQUATION WITH APPLICATION TO MILNE'S PROBLEM. I. De Corte, L. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Atomkernenergie; 24: No. 4, 259-265(1974).

14 refs. Part of a thesis.

The mono-energetic Boltzmann equation in plane geometry with isotropic scattering is approximately solved by expanding the angular neutron distribution in a double Jacobi polynomial system. The particular solution valid for any order of approximation is determined. The characteristic equation is derived in a closed form, and the angular distribution, flux and current are determined. For an absorbing medium and using a double Gegenbauer polynomial expansion, Milne's problem is solved. According to this method, the boundary conditions are fulfilled exactly. (auth)

4783 THREE-GROUP INVESTIGATION OF SPACE AND ENERGY DISTRIBUTIONS OF REACTOR NEUTRONS PENETRATING THROUGH IRON AND LEAD NEUTRON GUIDES. Troshev, T.; Khristov, V.; Apostolov, T. (Bylgarska Akademiya na Naukite, Sofia. Inst. za Yadrena Izsledvaniya i Yadrena Energetika). Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 181-190(1973). (In Bulgarian).

Investigations on the space and energy distributions of reactor neutrons passing through homogeneous and nonhomogeneous neutron guides placed in aquatic media are carried out. Iron and lead neutron guides are studied as well as neutron guides with periodic nonhomogeneity of paraffin or air. ^{10}B or ^{238}U coated miniature threshold counters are used in the experiments. Experimental data for the effective diffusion length in the neutron guides are obtained and compared with data from computation by making use of a 26-group computer program. Good agreement is observed. The spatial distribution of thermal and epithermal neutrons in the iron–paraffin neutron guide shows clearly expressed maxima, stronger for thermal neutrons, which may be explained with the higher attenuation coefficient for resonance neutrons in the iron. The effects are not seen in the lead–paraffin neutron guides. (INIS)

4784 MATHEMATICAL MODELLING OF THE SUBTHERMAL NEUTRONS SLOWING-DOWN IN THEIR PASSING THROUGH A SYSTEM OF FLAT ROTATING NEUTRON MIRRORS. Mircheva, D.; Kashukeev, N.; Yaneva, M. Sofia; Sofia Univ. (1974). vp. (In Bulgarian). INIS.

From 2nd national conference of the young physicists; Sofia, Bulgaria (10 Apr 1974).

Thesis.

The choice of optimal parameters of the system of rotating neutron mirrors and of the best conditions for the obtaining of ultracold neutrons requires detailed study of neutron delay by a mechanical way. In this paper the influence of some constructive features of the mechanical generator for ultracold neutrons (MGUCN) on the yield of delayed neutrons is discussed. The dependence of the yield of ultracold neutrons (UCN) on the velocity of rotation of MGUCN is studied. Three plots were obtained: for UCN reaching to the neutron-channel starting point, for UCN getting into neutron-channel and for neutrons which are not delayed enough when reaching the neutrons which are not de-

pendences give an optimal velocity of rotation of the system MGUCN of 80–100 radians per second. The dependence of the yield of UCN on the place of initial fall of the beam of subthermal neutrons on the rotating reflecting wall is studied. The distribution of UCN delayed sufficiently to get into the neutron-channel with respect to the time of delay at a definite radius vector of the initial reflection of the incident beam was obtained. Conclusions for the optimal opening of the neutron channel are given. (INIS)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 4660, 4747, 4845, 4847, 5139, 5168, and 5174.

4785 (CEA-N-1700, pp 11-13) $^4He + ^6Li$ AND $^4He + ^7Li$ REACTIONS. Foti, A. (Univ., Catania, Italy); Lepareux, M.; Pappalardo, G.; Saunier, N.; Strazzeri, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Preliminary results on the reactions induced by ^6Li and ^7Li ions on a ^4He target are reported. (auth)

4786 (CEA-N-1700, pp 130-137) GeV RANGE EXPERIMENTS. Baker, S. D. (Rice Univ., Houston, TX); Bertini, R.; Beurtey, R. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Experimental results obtained with the SPES I facility during 1973 are reviewed; they are mainly elastic and inelastic scattering of 1 GeV protons by ^4He, ^6Li, ^{12}C, ^{16}O, ^{58}Ni, ^{208}Pb. The reaction $^{12}C(p,d)^{11}C$ at 700 MeV protons and the quasi elastic process $(p,p\alpha)$ have also been under study. (FR)

4787 (CEA-N-1700, pp 185-186) $^4He(\gamma,p\pi^-)$(ppn) REACTION IN A BREMSSTRAHLUNG SPECTRUM IN THE REGION OF THE $\Delta(1236)$ RESONANCE. Andersson, G.; Argan, P.; Audit, G.; Faure, J. L.; Laget, J. M.; Martin, J.; Schuhl, C.; Tamas, G. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The cross section of the reaction $^4He + \gamma \rightarrow p + \pi^- +$ (ppn) was measured in the region of the first resonance for new values of the recoil momentum. The anomaly observed is confirmed. It appears that this anomaly cannot be explained by a one-nucleon process. (auth)

4788 (CEA-N-1700, pp 188) PHOTODISINTEGRATION OF HELIUM-4 INTO TWO FRAGMENTS. Argan, P.; Audit, G.; de Botton, N.; Faure, J. L.; Laget, J. M.; Martin, J.; Schuhl, C.; Tamas, G. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The $^4He(\gamma,p)t$ cross section is measured around $E_\gamma = 300$ MeV for two proton emission angles in the center of mass system ($\theta_p = 60°$ and $\theta_p = 90°$). The $^4He(\gamma,n)^3He$ cross section is also measured around $E_\gamma = 300$ MeV for two neutron emission angles in the center of mass system ($\theta_n = 90°$ and $\theta_n = 120°$). (auth)

4789 (ITP-74-165E) CLASSIFICATION OF ENERGY STATES FOR A FEW PARTICLES. Simenog, I. V. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 15p. Dep. NTIS (US Sales Only) $4.00.

The wave functions of the system A of interacting particles with oscillator potentials corresponding to the lowest shells are found explicitly. These functions are used for the analysis of the ground states of nuclei with $A \leq 6$. (auth)

4790 (JINR-D3-7991, pp 135-138) SEARCH FOR DOUBLY RADIATIVE np CAPTURE. Miller, P. D. (Oak Ridge National Lab., TN). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The discrepancy between experimental and theoretical values for the np capture cross section is discussed. A suggestion to resolve the discrepancy [Adler, Phys. Rev. C6, 1964 (1972)] would also result in an increased doubly radiative cross section. An experiment to observe this cross section (~42 μb) is described. (RWR)

4791 (JINR-P1-7742) ELASTIC SCATTERING OF $\pi^\pm$-MESONS ON ^3He AT 154 MeV. Al'bu, M.; Beshliu, T.; Mikhul, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 9p. (In Russian). INIS.

The differential cross section for the elastic scattering of π^+ and π^- mesons on ^3He was measured with a high-pressure He streamer chamber. A phase shift analysis was made and a set of phase shifts was obtained. The results were compared with data obtained earlier. (tr-auth)

4792 (LNF-74/63(L)) COLLISION THEORY FOR NUCLEAR INTERACTIONS AT INTERMEDIATE AND HIGH ENERGY. Kondratyuk, L. A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Nov 1974. 34p. Dep. NTIS (US Sales Only) $4.75.

The most important results on collision theory for nuclear interactions at intermediate and high energy are collected and their derivations given. The question, "What must one really know to calculate the cross section of some nuclear reaction?" is answered. Particles of short wave length are considered, and two types of reactions are discussed: interactions of elementary particles with nuclei and the interactions of heavy ions. (JFP)

4793 DIFFERENTIAL CROSS-SECTIONS FOR THE REACTIONS $^3He(n,p)T$ AND $^3He(n,d)D$. Paulsen, A.; Liskien, H. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 135-148 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Using the reciprocity theorem for nuclear reactions, differential cross sections for the reactions $^3He(n,p)T$ and $^3He(n,d)D$ are deduced from the corresponding $T(p,n)^3He$ and $D(d,n)^3He$ data. At the same time, new best curves for the total $^3He(n,p)T$ and $^3He(n,d)D$ cross sections are resulting from this conversion. (3 tables, 5 figures) (auth)

4794 $^3He(n,p)T$, $^6Li(n,\alpha)T$, AND $^{10}B(n,\alpha)$ STANDARD CROSS-SECTIONS. Stewart, L. (Los Alamos Scientific Lab., NM). pp 149-160 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The evaluated cross sections in the ENDF/B-III library are reviewed and compared with recent experimental measurements over the energy range established for each standard cross section. While the $^3He(n,p)$, $^6Li(n,\alpha)$ and $^{10}B(n,\alpha)$ data seem to be adequately established up to approximately 10 keV, the ^{10}B data should be separated into the α_0 and α_1 channels. All of the cross sections require further study above 10 keV to gain the precision necessary for standards. Recent experiments on ^{10}B carried out at Gulf Radiation Technology, San Diego, Calif. (GRT), are briefly discussed and the results presented. (auth)

4795 PROTON–PROTON REACTION AT HIGH ENERGIES. Sarazin, C. L. (Princeton Univ., NJ). Nuovo Cim.; 26B: No. 1, 94-98(11 Mar 1975).

Calculations of the proton-proton reaction $p + p \rightarrow d + e^+ + \nu_e$ at energies comparable to or greater than the Coulomb barrier are presented. Astrophysical and experimental applications are discussed briefly; it is shown that the competing reaction $e^- + p \rightarrow n + \nu_e$ will be the dominant means of converting protons to neutrons at high energies ($E \geq 0.5$ MeV) in most astrophysical situations. The thick target yield for the proton-proton reaction is unobservable even in the best conceivable current laboratory situations, being less than one reaction per 200,000 years for a μA current beam of one MeV in the center of mass. (auth)

4796 EVIDENCE FOR THE *D* STATE OF ^4He. Plattner, G.R.; Viollier, R.D.; Alder, K. (Physics Department, University of Basel, CH-4056 Basel, Switzerland). Phys. Rev. Lett. 34: No. 13, 830-833 (31 Mar 1975).

From a study of experimental phase shifts for $p+^4He$ elastic scattering at proton energies below 50 MeV we conclude that small *D*-state admixtures to the dominant *S*-state configuration exist in the ^4He ground state. This result is obtained by evaluating a forward dispersion relation for the $p+^4He$ spin-flip scattering amplitude. (auth)

4797 ASPECTS OF π-*d* SCATTERING IN A RELATIVISTIC THREE-BODY MODEL. Brayshaw, D.D. (Laboratory of Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. C 11: No. 4, 1196-1202 (Apr 1975).

A relativistic three-body model of the π-*d* system is employed to calculate elastic scattering in the (3, 3) resonance region. The results demonstrate that this effect is not related to a resonance pole in the π-*d* amplitude, and may be simply understood in terms of well-known rescattering singularities. Related questions concerning convergence of the multiple scattering series and pion absorption are discussed. (auth)

4798 ISOSPIN MIXING IN ^8Be WITH THE SUSSEX INTERACTION. Goldhammer, P. (Department of Physics, University of Kansas, Lawrence, Kansas 66045). Phys. Rev. C 11: No. 4, 1422-1425 (Apr 1975).

The Sussex harmonic oscillator matrix elements are employed to estimate the effect of cross terms between the nuclear interaction and the Coulomb potential. The 2p, 3p1h, and 4p2h corrections are calculated with second-order perturbation theory. The resulting matrix elements of the charge-dependent interaction yield excellent agreement with observed isospin mixing in ^{8}Be. Comparison is made to *G*-matrix calculations. (auth)

4799 CHARGE ASYMMETRY EFFECTS AND THE TRINUCLEON BINDING ENERGY. II. INCLUSION OF THE TENSOR FORCE AND SINGLET REPULSION. Gibson, B.F.; Stephenson, G.J. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 11: No. 4, 1448-1454 (Apr 1975).

Calculations of the trinucleon binding energy using separable potentials having a tensor component in the triplet force and strong repulsion in the singlet force are reported. It is shown that the binding energy remains sensitive to the *N-N* singlet effective range and that $|a_{nn}| < |a_{pp}|$ can be consistent with the ^{3}He Coulomb energy being less than the binding energy difference between ^{3}H and ^{3}He if one has $r_{nn} < r_{pp}$. Sensitivity of the binding energy to other differences in the *N-N* interactions is explored. (auth)

4800 OBSERVATION OF ELECTRIC MONOPOLE STRENGTH IN THE ELECTRODISINTEGRATION OF ^{3}He. Kan, P.T.; Peterson, G.A.; Webb, D.V.; Szalata, Z.M. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002); Fivozinsky, S.P.; Lightbody, J.W. Jr.; Penner, S. Phys. Rev. Lett. 34: No. 14, 899-901 (7 Apr 1975).

A broad electric monopole excitation peaking at 6.4 MeV has been observed in the breakup of ^{3}He induced by inelastic electron scattering. The monopole cross section was obtained from the observed cross section by subtracting the electric-dipole contributions converted from photodisintegration cross sections by using the virtual photon theory, and also subtracting the magnetic multipole contributions obtained from a 180° electron-scattering experiment. The extracted monopole matrix element is 2.4±0.5 fm^2. (auth)

4801 DISINTEGRATION OF THE DEUTERON BY α PARTICLES WITH ENERGY OF 27.2 MeV. Grantsev, V. I.; Dryapachenko, I. P.; Kornilov, V. A.; Nemets, O. F.; Pugach, V. M.; Rudenko, B. A.; Sokolov, M. V.; Struzhko, B. G. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2148-2156(Oct 1974). (In Russian).

The absolute differential cross sections for the reaction ^{2}H(α, αn)p were measured in a kinematically complete experiment. In the kinematic region studied the reaction proceeds by formation in the intermediate stage of ^{5}He in the ground and first excited states and ^{5}Li in the ground state and by quasi-free scattering of α particles on the neutron in the deuteron. The cross sections for the formation of ^{5}He$_{g.s.}$ and ^{5}Li$_{g.s.}$ in kinematically equivalent conditions are equal. The cross section for the quasi-free scattering of α particles on the neutron coincides in size with the cross section of quasi-free αp scattering and is equal to 80 mb·sterad^{-2}·MeV^{-1}. (9 figures) (tr-auth)

4802 TRITON WAVE FUNCTIONS IN THE OSCILLATOR BASIS. Mailing, L. (Inst. of Nuclear Physics, Prague); Rzhizek, I.; Plugarzh, Z. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2141-2147(Oct 1974). (In Russian).

The results of the numerical calculation of the binding energy, mean-square radius, and form factor of a three-particle system for a potential with and without consideration of weak repulsion were compared. The method used for the expansion of the wave functions was expansion in states of the translational-invariant shell model. The dependence of the calculated values on $\hbar\omega$ (oscillator frequencies) and N (maximum number of quanta) was shown. (tr-auth)

4803 NEGATIVE-PION CAPTURE BY ^{4}He. Kubodera, K. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Phys. Lett., B; 55: No. 4, 380-383(3 Mar 1975).

A simple way to explain the recent Virginia experiment on non-radiative π^- capture by ^{4}He is discussed. It is shown that the zero-range two-body absorption model (Eckstein model) supplemented by final-state enhancement factors can explain all essential features of the data. (auth)

4804 THE EFFECT OF RESONANCES IN ^{8}Be ON α-α BREMSSTRAHLUNG. Green, A. M.; Niskanen, J. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Nucl. Phys., A; 240: No. 2, 263-272(17 Mar 1975).

The effect of the quadrupole transition between the ^{8}Be 4^+ (11.4 MeV) and 2^+ (2.9 MeV) states is included in low energy α-α bremsstrahlung (E_{1ab} < 30 MeV). In the equal-angle Harvard geometry this dominates for $\theta < 30°$, and so enables an estimate to be made of B(E2,$4^+ \rightarrow 2^+$,^{8}Be). The problem of non-coplanarity is also discussed. (auth)

4805 SYSTEMATICS OF THE LIGHTEST NUCLEI. pp 30-55 of Legkie i Promezhutochnye Yadra Vblizi Granits Nuklonnoi Stabil'nosti. Baz, A. I.; Gol'danskii, V. I.; Gol'dberg, V. Z.; Zel'dovich, Ya. B. Moscow; Izdatel'stvo Nauka (1972). (In Russian).

From experimental data on pn scattering in the singlet state it is known that in this state the system (p + n) does not have a real level, but has a virtual level with an energy of 70 keV. From the hypothesis of a charge invariance of nuclear forces it follows that there is no bound state either in two neutrons (^{2}n–dineutron) or in two protons (^{2}He–diproton). At present there is considerable experimental data on the interaction of two protons and two neutrons in the final state. Analysis of this material definitely shows that there does not exist either a quasistationary dineutron or a quasistationary diproton. Therefore, three-nucleon systems will be considered later in this book. (tr-auth)

4806 INVESTIGATION OF THE α–p AND α–n FINAL-STATE-INTERACTION OF THE α-INDUCED DEUTERON BREAK-UP. Wallenwein, D. Heidelberg; Univ. Heidelberg (1974). 57p. (In German). INIS.

Thesis.

In a kinematically complete experiment the deuteron break-up was investigated under bombardment by α-particles with an energy of 23.7 MeV. The α-particle and the proton were detected in coincidence. At this energy the reaction is described by a step process via the compound nuclei ^{5}He and ^{5}Li. For both nuclei angular correlation measurements were performed between the proton (neutron) emitted in the first step and the α-particle from the decay of the ^{5}He(^{5}Li) compound nucleus. Both measurements could be described by the same correlation functions. From the angular distribution of the first reaction step, the process was determined to be a direct stripping reaction. Because of the long lifetime of the compound nuclei, the reaction partially has the character of a direct reaction under simultaneous production of the three final particles. The angular distribution of the cross-section shows that the probability of the reactions' proceeding via the ^{6}Li compound nucleus is only 6%. (GE)

4807 TIME-OF-FLIGHT SPECTROSCOPY OF CHARGED PARTICLES FROM PHOTODISINTEGRATION OF NUCLEI. Pla, M.; Skopik, D. M.; Murphy, J. J. II; Pla, C.; Shin, Y. M. (Saskatchewan Univ., Saskatoon (Canada). Saskatchewan Accelerator Lab.). Nucl. Instrum. Methods; 124: No. 2, 617-618 (1 Mar 1975).

Time-of-flight techniques have been applied to measurements of the ^{12}C(e,p)e' ^{11}B and H(e,p)e reactions. The results indicate that this TOF method can be used for wide ranges of experiments with bremsstrahlung beams. (auth)

4808 EFFECT OF NUCLEON OVERLAP ON INELASTIC SHADOWING IN THE DEUTERON. Harrington, D. R. (Oslo Univ. (Norway). Fysisk Instituut). Nucl. Phys., B; 87: No. 3, 413-425(10 Mar 1975).

Calculations of the inelastic shadowing correction to the deuteron total cross section have assumed that the overlap of the nucleons in the deuteron can be ignored, and that therefore these corrections can be expressed in terms of on-shell inelastic scattering amplitudes. The effect of overlap is studied in coupled-channel potential theory. The results suggest that the no-overlap assumption may lead to large errors for highly inelastic channels. The exact result may be much larger than that obtained with no-overlap assumption. (auth)

4809 TEST OF THE VALIDITY OF THE ADIABATIC APPROXIMATION IN SCATTERING THEORY. Avishai, Y. (Ben-Gurion Univ. of the Negev, Beersheba (Israel)); Rinat, A. S. (Weizmann Inst. of Science, Rehovoth (Israel)). Phys. Lett., B; 55: No. 2, 153-156(3 Feb 1975).

Exact solutions for the scattering of a fast projectile x on deuterium are compared with various versions of the fixed scatterers approximation. The content of the approximations for a nucleon and a different projectile is discussed. The calculations show the approximate agreement of angular distributions in the forward direction and the amount of disagreement in the backward hemisphere. In the case of nucleon scattering the importance of nucleon exchange, neglected in the FSA, is explicitly demonstrated. As expected, the quality of the tested approximations rapidly improves with diminishing mass ratio M_x/M_N. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 4187, 4262, 4560, 4578, 4786, 4794, 4804, 4879, 4881, 4951, 4956, 4971, 4997, 5037, 5053, 5104, 5137, 5168, 5179–5181, 5190, and 5203.

4810 (CEA-N-1700, pp 13-14) STUDY OF d-α ANGULAR CORRELATIONS AT 0°. Avril, M.; Bianchi, L.; Fotti, A.; Lepareux, M.; Pappalardo, G.; Saunier, S.; Stazzeri, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The experimental apparatus to measure particle-particle angular correlation was tested. Preliminary results are reported for ^{12}C (^{6}Li,d)$^{16}O(\alpha)^{12}C$. (auth)

4811 (CEA-N-1700, pp 15-17) REACTIONS INDUCED BY 46 MeV ^{12}C PROJECTILES WITH ^{16}O AND ^{24}Mg TARGETS. Conjeaud, M.; Harar, S.; Da Silveira, E.; Volant, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Angular distributions were obtained for (^{12}C, ^{11}B), (^{12}C, ^{10}Be) and (^{12}C, ^{9}Be) with ^{26}Mg and for (^{12}C, ^{10}Be) with ^{18}O. A DWBA analysis was performed using Bonche and DeVries codes; a good agreement was obtained with experimental results. The spectroscopic factors extracted from (^{12}C, ^{11}B) transfer are in good agreement with those derived from (^{3}He,d). The selectivity observed in two-proton transfer is strongly dependent of both angular momentum matching and configuration mixing in projectile and target. (auth)

4812 (CEA-N-1700, pp 18-19) STUDY OF THE $^{12}C(^{14}N,^{6}Li)^{20}Ne$ REACTION MECHANISM. Conjeaud, M.; Harar, S.; Lee, S. M.; Lepine, A.; Da Silveira, E.; Volant, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Excitation functions of ^{20}Ne levels observed up to 10 MeV excitation energies have been obtained at few angles and from 40 to 60 MeV incident energy by step of 5 MeV. The agreement of data with Hauser-Feshbach calculations is quite good and shows that the compound nucleus formation is the main process of this reaction in this energy region. (auth)

4813 (CEA-N-1700, pp 19-23) HIGH SPIN LEVELS IN ^{20}Ne. Conjeaud, M.; Harar, S.; Panagiotou, A. D.; Da Silveira, E.; Volant, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

High energy ^{20}Ne levels were studied by means of angular correlations techniques using the $^{12}C(^{12}C,\alpha)^{20}Ne(\alpha)^{16}O$ and $^{16}O(^{7}Li,t)^{20}Ne(\alpha)^{16}O$ reactions. Excitation functions were also obtained and the analysis using the Hauser-Feshbach code is underway. (auth)

4814 (CEA-N-1700, pp 23-25) POPULATION OF HIGH SPIN STATES FROM $^{12}C(^{16}O,\alpha)^{24}Mg$ REACTION. Berthier, B.; Badawy, I.; Gastebois, J.; Fernandez, B.; Lee, S. M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973).

An analysis of excitation functions of the reaction $^{12}C(^{16}O,\alpha)^{24}Mg$ in the framework of the Hauser-Feshbach statistical model gives a very good agreement for levels of known spin and is used as a means of determining high spins within one or two units of h. (auth)

4815 (CEA-N-1700, pp 25-26) INTERMEDIATE RESONANCE IN THE INTERACTION $^{16}O + ^{12}C$ at E_{cm} = 22.7 MeV. Badawy, I. (Cairo Univ.); Berthier, B.; Charles, P.; Fernandez, B.; Gastebois, J.; Lee, S. M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Strong structures, about 600 keV wide, appear in several channels, near 22.7 MeV. This suggests the existence of an intermediate resonance in the compound system ^{28}Si, near 39.2 MeV excitation. The angular distribution of the elastic scattering at 22.7 MeV is well fitted at backward angles (150° to 176°) with $[P_l = 16\ (\mathrm{Cos}\ \theta)]^2$ which corresponds to the grazing orbital angular momentum at this energy. This would be a situation very similar to the l = 14 resonance observed at 19.7 MeV. (auth)

4816 (CEA-N-1700, pp 115-118) ANALYSIS OF THE INELASTIC SCATTERING OF POLARIZED PROTONS ON ^{16}O AT 24.5 MeV. Escudie, J. L.; Lombard, R.; Pignanelli, M.; Resmini, F.; Tarrats, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Differential cross sections and analyzing powers for polarized (p,p') scattering on ^{16}O are analyzed in the framework of microscopic antisymmetrized DWBA. For collective levels, the use of an imaginary form factor improves significantly the fits. However, important discrepancies remain, which are attributed to the lack (or insufficiency) of deformed components in the wave functions, and the lack of two-step mechanism description. (auth)

4817 (CEA-N-1700, pp 118-122) STUDY OF THE (^{3}He,t) REACTION ON ^{15}N BETWEEN 16.5 AND 37.7 MeV. Pignanelli, M. (Institut de Physique, Milan); Resmini, F. G.; Escudie, J. L. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The energy dependence of elastic diffusion of ^{3}He on ^{15}N and charge exchange (^{3}He,t) between 16.5 and 37.7 MeV are investigated. The DWBA calculations give interesting cross sections for the charge exchange reactions, while the observed cross sections decrease with energy. (auth)

4818 (CEA-N-1700, pp 137-141) CALCULATIONS OF ELASTIC AND INELASTIC SCATTERING TO FIRST ORDER OF MULTIPLE SCATTERING THEORY. Gustafsson, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

A first order optical potential is calculated for the scattering of 1 GeV protons from ^{12}C, ^{58}Ni and ^{208}Pb. Angular distributions for the elastic scattering are calculated. Comparison with experiment shows a qualitative agreement. A strong sensitivity to the forward values of the n-n amplitudes is exhibited for ^{208}Pb, as well as to the spin amplitude in the case of ^{12}C. The exact solution for the scattering amplitude is compared with the one obtained from the eikonal approximation. Discrepancies occur in the vicinity of the minima and increase with angle. Inelastic angular distributions are calculated for the first 2^+ and 3^- states of ^{12}C. Poor agreement with the experiment is revealed. (auth)

4819 (CEA-N-1700, pp 193-195) ANALYSIS OF (e,e'p) EXPERIMENTS WITH ^{12}C, ^{28}Si, ^{40}Ca, AND ^{58}Ni. Bernheim, M.; Gillebert, A.; Mougey, J.; Priou, M.; Royer, D.; Sick, I.; Wagner, G. J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973).

The (e,e'p) results on ^{12}C, ^{28}Si, ^{40}Ca and ^{58}Ni were corrected for radiative effects. Experimental values for proton mean kinetic and removal energies were extracted in the framework of DWIA. Good fits were obtained on the proton momentum distributions in ^{12}C with Woods-Saxon wave functions in agreement with electron scattering. (auth)

4820 (CEA-N-1700, pp 196-197) (e,e'X) COINCIDENCE EXPERIMENTS ON ^{6}Li, ^{9}Be, AND ^{24}Mg. Genin, J. P.; Julien, J.; Letourneau, R.; Mougeot, A.; Palmeri, A.; Rambaut, M.; Samour, C.; Vinciguerra, D. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Coincidence experiments of the type (e,e'X) where X is proton, deuteron, triton, or alpha, were studied with two magnetic spectrometers. Heavy particles were detected in solid state detectors. Momentum distributions were obtained for ^{6}Li. Cross sections for different nuclei are compared. (auth)

4821 (JINR-P1-8463) ASSOCIATIVE MULTIPLICITIES IN π^- C-INTERACTIONS AT pc = 40 GeV WITH THE BACKWARD PROTON EMISSION IN THE L. C. S. Azimov, S. A.; Grishin, V. G.; Inogamova, T. Ya.; Inogamov, Sh. V.; Lyubimov, V. B.; Semerdzhev, Kh.; Tuvdendorzh, D.; Usmanov, T. M.; Yuldashev, A. A.; Yuldashev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Associative multiplicities were investigated for the reaction $\pi^- + ^{12}C \rightarrow p$ (backward in l.s) + X at 40 GeV/c. The analysis shows that marked correlations are not observed between protons emitted into backward and forward hemispheres in the lab. coordinate system. The multiplicity of relativistic charged particles does not depend on the properties of protons emitted backward in the lab. system. (4 figures, 1 table) (auth)

4822 (ORNL-TM-4885, p 4) NEUTRON TOTAL CROSS SECTION OF ^{6}Li. Harvey, J. A.; Hill, N. W. Apr 1975.

In report to the U. S. Nuclear Data Committee.

4823 (RLO-1388-258, pp 39-42) ISOSPIN FORBIDDEN PROTON DECAYS OF THE LOWEST T = 3/2 LEVEL IN ^{13}N. Adelberger, E. G.; Cooper, M. D.; Marrs, R. E.; Snover, K. A. Jun 1974.

In annual report, 1974.

4824 (RLO-1388-258, pp 43-45) PRODUCTION OF ^{6}Li, ^{9}Be, AND ^{10}B IN THE PROTON BOMBARDMENT OF ^{13}C. Bodansky, D.; Chamberlin, D.; Jacobs, W. W.; Oberg, D. L. Jun 1974.

In annual report, 1974.

4825 (RLO-1388-258, pp 52-59) PARITY MIXING OF THE GROUND STATE DOUBLET IN ^{19}F. Adelberger, E. G.; Cooper, M. D.; Swanson, H. E.; Tape, J. W.; Trainor, T. A. Jun 1974.

In annual report, 1974.

4826 (RLO-1388-258, pp 60-63) FEASIBILITY OF DIRECTLY MEASURING THE $\Delta T = 1$ PARITY VIOLATING FORCE. Adelberger, E. G.; Bussoletti, J. E. Jun 1974.
In annual report, 1974.

4827 (RLO-1388-258, pp 75-77) DEPOLARIZATION IN ELASTIC SCATTERING OF 18 MeV PROTONS FROM ^{9}Be. Baker, M. P.; Cramer, J. G.; Tape, J. W.; Trainor, T. A.; Weitkamp, W. G.; Wieman, H. Jun 1974.
In annual report, 1974.

4828 (RLO-1388-258, pp 88-90) ANALYZING POWER FOR ELASTIC SCATTERING OF PROTONS FROM ^{12}C. Baker, M. P.; Cramer, J. G.; Dunham, J. S.; Trainor, T. A.; Weitkamp, W. G. Jun 1974.
In annual report, 1974.

4829 (RLO-1388-258, pp 96-99) ANALYSIS OF THE ^{12}C(^{12}C,^{8}Be)^{16}O REACTION NEAR $E_{c.m.}$ = 6.0 MeV. Cooper, M. D. Jun 1974.
In annual report, 1974.

4830 (RLO-1388-258, pp 103-106) ^{12}C(^{14}N,^{13}N)^{13}C REACTION AT 100 MeV. Cramer, J. G.; DeVries, R. M.; Liu, K. L.; Zisman, M. S.; Becchetti, F. D.; Harvey, B. G.; Homeyer, H.; Kovar, D. G.; Mahoney, J.; von Oertzen, W. Jun 1974.
In annual report, 1974.

4831 (RLO-1388-258, pp 107-108) ELASTIC TRANSFER REACTION ^{12}C(^{14}N,^{14}N)^{12}C. Chan, Y. D.; Cramer, J. G.; Cuengco, B.; Liu, K. L.; Zisman, M. S. Jun 1974.
In annual report, 1974.

4832 (RLO-1388-258, pp 117-123) SEARCH FOR ISOSPIN-VIOLATING EFFECTS IN γ-DECAYS OF THE LOWEST $T = 3/2$ LEVELS IN ^{13}C AND ^{13}N. Adelberger, E. G.; Cooper, M. D.; Marrs, R. E.; Snover, K. A. Jun 1974.
In annual report, 1974.

4833 (RLO-1388-258, pp 132-135) ^{11}B(p,γ)^{12}C REACTION TO EXCITED STATES OF ^{12}C. Paul, P.; Snover, K. A. Jun 1974.
In annual report, 1974.

4834 (RLO-1388-258, pp 139-140) STUDY OF THE MECHANISM OF THE RADIATIVE CAPTURE OF LOW ENERGY NUCLEONS BY ^{12}C. Johnson, D. L. Jun 1974.
In annual report, 1974.

4835 (RLO-1388-258, pp 150-152) RADIATIVE CAPTURE OF FAST NEUTRONS. Arthur, E. (Los Alamos Scientific Lab., NM); Drake, D.; Halpern, I. Jun 1974.
In annual report, 1974.

4836 (RLO-1388-258, pp 197-201) RADIATIVE PROTON CAPTURE BY CARBON-12. Berghofer, D. (Univ. of British Columbia, Vancouver); Ebisawa, K.; Hasinoff, M. D.; Lim, B.; Measday, D. F.; Mullingan, T. J. Jun 1974.
In annual report, 1974.

4837 ^{6}Li(nα) CROSS-SECTION. Poenitz, W. P.; Meadows, J. W. (Argonne National Lab., IL). pp 95-104 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).
From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-
Measurements of the ^{6}Li(n,α) cross section were carried out in the 30- to 600-keV energy range using the Grey Neutron Detector. Of major interest was the ratio between the peak of the resonance and the minimum between 80 keV and 100 keV for which a value of 4.96 was obtained. The present $\sigma_{n,\alpha}$ values were combined with recent σ_{tot} measurements in an attempt to fit both cross sections with one set of resonance parameters. Both the fitting results and the absolute cross-section values are preliminary. (5 figures) (auth)

4838 MEASUREMENTS OF THE RELATIVE ^{6}Li(n,α) CROSS-SECTION IN THE ENERGY RANGE 1 keV TO > 500 keV. Coates, M. S.; Hunt, G. J.; Uttley, C. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 105-111 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).
From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.
The ^{6}Li(n,α)T cross section has been measured between 1 keV and 500 keV using the neutron booster–45-MeV linac system and the Harwell black detector as flux monitor. Data have been obtained for two 6.35-cm dia. ^{6}Li-loaded glasses, one 0.5 mm thick and the other 9.5 mm thick. The background was determined using the black-resonance technique, and corrections for multiple scattering were made using Monte-Carlo calculations. In contradiction to preliminary results, the cross sections determined for the thick and thin glasses agree. The new results agree well with those obtained by Fort and Marquette if systematic energy shifts of approximately 5 keV are introduced. The peak cross section value is about 10% lower than the peak value of the (n,α) cross section derived by Uttley and Diment from their measurements of the ^{6}Li total cross section. (2 figures, 1 table) (auth)

4839 EXPERIMENTAL METHODS USED AT CADARACHE TO DETERMINE THE ^{6}Li(n,α)T CROSS-SECTION BETWEEN 20 keV AND 1700 keV. Fort, E.; Marquette, J. P. (CEN de Cadarache, France). pp 113-117 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).
From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.
The ^{6}Li(n,α)T cross-section has been measured absolutely in the energy range 20 keV to 1700 keV using ^{6}Li glass scintillators and the Cadarache Van de Graaff. The ^{6}Li content of the scintillators was determined from low-energy transmission measurements made with the 60-MeV Saclay linac and by comparison with other glass scintillators whose ^{6}Li content had been determined absolutely by the phase oscillation technique. The efficiencies of the glass scintillators were measured by two methods: (1) associated ^{3}He particles from the T(p,n)^{3}He reaction were detected in coincidence with neutrons counted in the glass scintillators; (2) using time-of-flight techniques, the responses of the glass scintillators were compared with the response of a BF_3 counter previously calibrated by both the associated-particle and $MnSO_4$ bath techniques. The ^{6}Li(n,α)T cross-sections derived from the two efficiency measurements agree within experimental error, except for an unexplained discrepancy of about 5% at the peak of the approximately 250-keV resonance. (1 figure) (auth)

4840 ANALYSIS OF EXPERIMENTAL METHODS AND PROPOSAL OF RECOMMENDED VALUES FOR THE ^{6}Li(n,α)T REACTION BETWEEN 20 keV AND 1700 keV. Fort, E. (CEN de Cadarache, France). pp 119-126 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).
From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.
Upper and lower bounds for the (n,α) and elastic scattering cross-sections of ^{6}Li have been calculated from the best known properties of the ^{6}Li + n system. These limits were obtained by keeping the total width constant but varying the ratio of the alpha and neutron partial widths. Measurements of the (n,α) and elastic cross-sections which fell outside these limits and measurements which were uncorrected for extraneous and multiple scattering effects were eliminated. The remaining experimental data appeared to converge and could be fitted with a mean deviation of 4% by an R-matrix formalism in the one-level and two-open-channel approximation. Recommended values and recommendations for further experimental work are given. (2 figures, 2 tables) (auth)

4841 PRELIMINARY MEASUREMENT OF THE RELATIVE ^{10}B(n,α,γ) CROSS-SECTION. Coates, M. S.; Hunt, G. J.; Uttley, C. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 129-132 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).
From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.
Recent measurements of the ^{10}B(n,α,γ) cross section on the 120-m flight path of the Harwell neutron-booster linac system have been re-analyzed using a more accurate measurement of the neutron flux spectrum. The data are compared with a recent evaluation by Sowerby et al. (1 figure, 1 table) (auth)

4842 ELECTRON SCATTERING FROM ^{18}O AND ^{40}Ar. Groh, J. L. Saskatoon, Saskatchewan; Univ. of Saskatchewan (1974). 252p. University Microfilms Order No. 75-8295.
Thesis (Ph. D.).
The 140 MeV Saskatchewan linac has been used to investigate the nuclei argon-40 and oxygen-18. The rms charge radius of ^{40}A was measured by elastic scattering in the momentum transfer range $0.5 < q < 0.85$ F^{-1}. The result obtained using a phase shift code and assuming a Fermi distribution was 3.473 ± 0.045 F. Inelastic cross sections of ^{40}A were measured in the range $0.3 < q < 1.15$ F^{-1} for excitation energy below 4.6 MeV while ^{18}O cross sections were measured in the range $0.5 < q < 1$ F^{-1} for energy below 6 MeV. The nuclear form factors for these states were derived from the experimental cross sections in plane wave Born approximation, after correcting the data for Coulomb distortion of the electron waves. The generalized Helm model, which is a collective model, was used to parameterize the experimental form factors. This yielded information on the spins and parities of states in the uncertain ^{40}A spectrum, separated out the longitudinal and transverse components of each form factor and established ground state transition probabilities. Form factors were calculated for the even spin states in ^{18}O from the wave functions

of Benson and Irvine. The model, which assumes the coexistence of spherical shell model states with a single deformed four particle-two hole state, gave excellent agreement with the experimental results. (Diss. Abstr. Int., B)

4843 EXCITATION FUNCTIONS FOR THE REACTIONS $^{12}C(\pi^+,\pi N)^{11}C$ OVER THE REGION OF THE (3,3) RESONANCE. Dropesky, B.J.; Butler, G.W.; Orth, C.J.; Williams, R.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Friedlander, G.; Yates, M.A.; Kaufman, S.B. Phys. Rev. Lett. 34: No. 13, 821-824 (31 Mar 1975).

The excitation functions for the reactions $^{12}C(\pi^+,\pi N)^{11}C$ have been measured by activation over the energy ranges 50 to 470 MeV for π^+ and 40 to 550 MeV for π^-. These excitation functions, clearly reflecting the (3,3) pion-nucleon resonance, show an upward energy shift in the resonance peak for π^- and a downward shift for π^+. The $\sigma_{\pi^-}/\sigma_{\pi^+}$ ratio at 180 MeV is 1.55 ± 0.10. (auth)

4844 EFFECTS OF NUCLEON CHARGE EXCHANGE ON THE (π, πN) PUZZLE. Sternheim, M.M. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002); Silbar, R.R. Phys. Rev. Lett. 34: No. 13, 824-827 (31 Mar 1975).

Charge-exchange interactions of the nucleons within the nucleus are shown to account for the observed differences in the ratios of neutron-knockout cross sections for π^+ from the impulse-approximation predictions. Also, the energy dependence of the knockout cross sections is obtained from the measured total pion reaction cross sections with a simple model for the threshold behavior. (auth)

4845 $^{10}B(\alpha, n_0)^{13}N$ AND $^{10}B(\alpha, p_1)^{13}C$ FOR $2 < E_\alpha < 8$ MeV. Wilson, S.J. (University of Wisconsin, Madison, Wisconsin 53706). Phys. Rev. C 11: No. 4, 1071-1082 (Apr 1975).

We present simultaneously obtained data for the mirror reactions $^{10}B(\alpha, n_0)^{13}N$ and $^{10}B(\alpha, p_0)^{13}C$ and interpret the yield ratio with the formula of Barker and Mann. All but one of the isospin-mixed levels emit neutrons more copiously than protons, although we might expect about half of them to emit protons more copiously. We also present $^{10}B(\alpha, p_1)^{13}C$ cross sections for groups which leave ^{13}C in the $1/2^-$ ground state; and in the $1/2^+$ 3.086, $3/2^-$ 3.684, and $5/2^+$ 3.854 MeV excited states. We expanded the angular distributions in Legendre polynomials and fitted the coefficients at some of the resonances with compound nucleus scattering theory, obtaining spin-parity assignments: 1^+ at $E_x(^{14}N) = 13.16$, 2^- at 13.24, $(2^+, 2^-, 3^+)$ at 13.67, and $(1^+, 1^-)$ at 13.76 MeV. As part of the calibration of the neutron spectrometer, we found the total $^3He(n, p)^3H$ cross section is 422 ± 58 mb for 3.5 MeV neutrons. This value is about 20% lower than currently accepted values. (auth)

4846 DISINTEGRATION OF ^{12}C, ^{19}F, ^{35}Cl, ^{63}Cu, AND ^{65}Cu BY REAL AND VIRTUAL RADIATION. Wolynec, E.; Moscati, G.; Moreira, J.R.; Gonçalves, O.D.; Martins, M.N. (Instituto de Física da Universidade de São Paulo, São Paulo, Brazil). Phys. Rev. C 11: No. 4, 1083-1088 (Apr 1975).

Yield curves were measured for one-neutron emission in ^{12}C, ^{19}F, ^{35}Cl, and ^{65}Cu, and for two-neutron emission in ^{63}Cu, with target stacks which were bombarded by electrons. The results were analyzed to compare the yields from the direct effect of the electrons with those resulting from bremsstrahlung from the electrons. The analysis was carried out with the virtual photon method in the plane-wave Born approximation and the distorted-wave Born approximation (DWBA). Agreement with DWBA predictions is obtained assuming photoabsorption through $E1$ transitions. (auth)

4847 MASSES OF ISOTOPES OF H, He, C, N, O, AND F. Smith, L.G. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540); Wapstra, A.H. Phys. Rev. C 11: No. 4, 1392-1400 (Apr 1975).

The mass differences of 17 doublets involving the atoms ^3H, ^3He, ^4He, ^{13}C, ^{14}C, ^{14}N, ^{15}N, ^{16}O, and ^{19}F have been measured with a rf mass spectrometer. By least-squares adjustment, best values are obtained for the masses of these eight atoms for which the estimated errors are materially less than for previously published values. By using Einstein's mass-energy relation very accurate values are derived for the β decay energies of ^3H and ^{14}C and for the neutron binding energies in ^{13}C, ^{14}C, and ^{15}N. The last ones offer a possibility to improve the calibration for multi-MeV (capture) γ rays by an order of magnitude. (auth)

4848 DECAY OF THE ^{10}Be 0^+ 6.18-MeV LEVEL. Wagner, P.; Freeman, R.M.; Gallmann, A.; Warburton, E.K. (Centre de Recherches Nucléaires et Université Louis Pasteur, Laboratoire de Physique Nucléaire et d'Instrumentation Nucléaire, Strasbourg, France). Phys. Rev. C 11: No. 4, 1459-1460 (Apr 1975).

The relative branching ratios of the ^{10}Be 6.18-MeV level to the 1^- 5.96- and 2^+ 3.37-MeV levels were measured via the $^{11}B(t, \alpha\gamma)^{10}Be$ reaction. The results of (24 ± 2) % and (76 ± 2) %, respectively, are in agreement with a recent $^9Be(n, \gamma)^{10}Be$ experiment and in disagreement with the previous $^9Be(d, p\gamma)^{10}Be$ results. (auth)

4849 $^{14}C(p, \alpha)^{11}B$ REACTION FOR 4 MeV $< E_p <$ 7.5 MeV. Weller, H.R.; Blue, R.A. (Department of Physics, University of Florida, Gainesville, Florida 32611); Ramirez, J.J.; Bernstein, E.M. Phys. Rev. C 11: No. 4, 1464-1467 (Apr 1975).

The $^{14}C(p, \alpha_0)^{11}B$ cross sections are presented for 4 MeV $< E_p <$ 7.5 MeV. Probable spin assignments based on Legendre polynomial fits to the measured angular distributions are given and compared to the $^{14}C(p, p)^{14}C$ results. (auth)

4850 RESONATING-GROUP STUDY AND IMPORTANCE OF EXCHANGE PROCESSES IN $N + ^{16}O$ SCATTERING. Thompson, D.R.; Tang, Y.C. (School of Physics, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 11: No. 4, 1473-1476 (Apr 1975).

The scattering of nucleons by ^{16}O is studied with the resonating-group method and a generator-coordinate technique. The result shows that, at relatively high energies, the knockout process contributes significantly to the scattering amplitude, while the pickup process is of minor importance. (auth)

4851 CALCULATION OF PARITY MIXING IN ^{19}F. Gari, M. (Institut für Theoretische Physik, Ruhr-Universität Bochum, Germany and Max-Planck-Institut für Chemie, Mainz, Germany); Huffman, A.H.; McGrory, J.B.; Offermann, R. Phys. Rev. C 11: No. 4, 1485-1487 (Apr 1975).

The conventional model of weak interactions is tested in the case of the recently measured γ asymmetry in ^{19}F. It is shown that the conventional model leads to an asymmetry δ about one-fourth to one-third of the experimental value. Extra currents in the hadronic part of the weak interaction could be an explanation for this discrepancy. (auth)

4852 CROSS SECTION RATIOS FOR (π^+, πN) REACTIONS ON ^{16}O NEAR THE Δ (1236) RESONANCE. Lieb, B.J. (George Mason University, Fairfax, Virginia 22030); Plendl, H.S.; Funsten, H.O.; Kossler, W.J.; Stronach, C.E. Phys. Rev. Lett. 34: No. 15, 965-968 (14 Apr 1975).

Ratios of cross sections for 200-MeV π^+ reactions on ^{16}O leading to mirror levels in ^{15}O and ^{15}N, observed by their γ decays, were measured and compared. For the first $3/2^-$ levels, the ratios are $(^{15}O/^{15}N)_{\pi^-} = 1.7 \pm 0.4$ and $(^{15}O/^{15}N)_{\pi^+} = 1/(1.8 \pm 0.4)$, indicating charge symmetry. (auth)

4853 ENERGY SPECTRA OF p-SHELL NUCLEI AND VELOCITY-DEPENDENT EFFECTIVE POTENTIAL. Dzhibuti, R. I.; Sallam, Kh. M. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2054-2058(Oct 1974). (In Russian).

The energy spectra of p-shell nuclei were calculated in the shell model approximation by using the velocity-dependent effective potential of s-wave interactions. It was shown that this potential makes it possible to describe simultaneously with good accuracy both the binding energy and radius and the energy spectra of low-lying states of ^6Li. (1 figure, 1 table) (tr-auth)

4854 STATISTICAL COMPOUND PROCESSES IN LIGHT NUCLEI. Stokstad, R. G. (Yale Univ., New Haven). pp 327-361 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

This paper discusses two principal questions: How reliably can cross sections for heavy-ion compound-nucleus reactions be predicted. What can be learned from those reactions which proceed via statistical compound processes. The rationale for using a statistical model is examined first. Certain heavy-ion reactions show a selective population of high-spin states in the residual nuclei while others do not; this phenomenon of selectivity and its spectroscopic applications are considered. The importance of the critical angular momentum in the entrance channel and in the compound nucleus is treated. The topics of level densities and isospin are discussed, and further applications are presented. (28 figures, 4 tables) (RWR)

4855 NEUTRON PRODUCTION CROSS SECTIONS AND ENERGIES FOR THE REACTIONS $^7Li(p,n)^7Be$ AND $^7Li(p,n)^7Be^*$. Liskien, H.; Paulsen, A. (Joint Nuclear Research Center, Geel, Belgium). At. Data Nucl. Data Tables; 15: No. 1, 57-84(Jan 1975).

Center-of-mass best values for the normalized Legendre coefficients and the 0° differential cross sections as functions of input energy were derived from various experimental results for the reactions $^7Li(p,n)^7Be$ and $^7Li(p,n)^7Be^*$ (431 keV). This information was used to calculate laboratory differential cross sections as functions of the laboratory proton energy and neutron emission angle, which are given in tabular form together with the corresponding neutron energies. (5 figures, 10 tables) (auth)

4856 MECHANISM OF THE $(^3He,\alpha)$ REACTION ON THE ^{12}C NUCLEUS. Doskeev, G. A.; Zhusupov, M. A.; Ibraeva, E. T. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2157-2160(Oct 1974). (In Russian).

Available experimental data on the $(^3He,\alpha)$ reaction on ^{12}C were analyzed. Special attention was given to the $\frac{5}{2}^-$ and $\frac{7}{2}^-$ excited states in the nucleus ^{11}C transitions to which are forbidden by the shell selection rules for the neutron pickup mechanism. The calculations made showed that the mechanism of cluster substitution is predominant at incident particle energies of 16 to 18 MeV during scattering in the forward hemisphere. (2 figures) (tr-auth)

4857 THE DETERMINATION OF THE NUCLEAR CHARGE DISTRIBUTION OF ^{12}C FROM ELASTIC ELECTRON SCATTERING. Friar, J. L. (Brown Univ., Providence, R. I. (USA). Dept. of Physics); Negele, J. W. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). Nucl. Phys., A; 240: No. 2, 301-333(17 Mar 1975).

By using an iterative procedure previously applied to ^{208}Pb, the static nuclear charge distribution for ^{12}C and the error and error correlations in coordinate space implied by the experimental statistical errors are determined from experimental electron scattering data at three energies. Pseudodata generated from a known charge distribution and randomized according to the experimental errors are investigated extensively to demonstrate the validity of the method. Deformed and spherical Hartree–Fock calculations with phenomenological and realistic forces are compared with experiment, and the effect of dispersion corrections on the analysis is shown to be small. Various corrections to the experimental data are discussed, and the analysis is compared with other current approaches. (auth)

4858 A GENERATOR COORDINATE DESCRIPTION OF THE BREATHING MODE. Krewald, S.; Galonska, J. W.; Faessler, A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik). Phys. Lett., B; 55: No. 3, 267-269(17 Feb 1975).

Isoscalar and isovector breathing mode states in ^{16}O and ^{208}Pb are described in the generator coordinate method. The MDI 4-force, which yields a nuclear matter compressibility of K_N = 200 MeV (in agreement with realistic forces) and a symmetry energy of S_N = 32.8 MeV, was used. (auth)

4859 CIRCULAR POLARIZATION IN ^{18}F AS A PROBE FOR NEUTRAL CURRENTS. Gari, M.; Offermann, R. (Bochum Univ. (F. R. Germany). Inst. fuer Theoretische Physik); McGrory, J. B. (Oak Ridge National Lab., Tenn. (USA)). Phys. Lett., B; 55: No. 3, 277-280(17 Feb 1975).

A discussion of the circular polarization of the 1.08 MeV transition (0^-, I = 0 1^+, I = 0) in ^{18}F as a test for neutral currents is presented. Calculations for the Cabibbo model of weak interactions predict a value for the polarization of the 1.08 MeV photons of $|\delta_c| = 3.6 \times 10^{-4}$. This value is considerable larger than previously estimated. Inclusion of neutral currents via the Weinberg–Salam model results in a considerable enhancement: $|\delta_w| = 5.7 \times 10^{-3}$. The measurement of the circular polarization or asymmetry of the 1.08 MeV photons, therefore, is likely to be one of the most promising parity experiments, and should be done in the near future. (auth)

4860 MEASUREMENT OF p–C ANALYZING POWER WITH A SMALL ANGLE SCATTERING SYSTEM. Aebischer, D.; Favier, B.; Greeniaus, G.; Hess, R.; Junod, A.; Lechanoine, C.; Nikles, J. C.; Rapin, D.; Werren, D. (Geneva Univ. (Switzerland)). Nucl. Instrum. Methods; 124: No. 1, 49-60(15 Feb 1975).

The p–C analyzing power for $4° \lesssim \theta_{lab} \lesssim 20°$ has been measured at incident proton energies of 399, 462, 500, 515, 530 and 576 MeV. Multiwire proportional chambers were placed directly in a polarized proton beam, and the azimuthal symmetry of the scattered protons was observed. Unscattered protons were rejected with an electronic fast decision system. Some effects of inelastic scattering on the analyzing power have also been investigated. (auth)

4861 SINGLE PROTON EMISSION FROM π^- ABSORPTION AT REST IN ^{12}C. Coupat, B.; Bertin, P. Y.; Isabelle, D. B.; Vernin, P. (Clermont-Ferrand Univ., 63 (France). Lab. de Physique Corpusculaire); Gerard, A.; Miller, J.; Morgenstern, J.; Picard, J.; Saghai, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire). Phys. Lett., B; 55: No. 3, 286-288(17 Feb 1975).

The absorption of π^- at rest on ^{12}C leading to ^{11}Be is measured using the activation technique. The probability for single proton emission per stopped pion is $(4.5 \pm 0.8) \times 10^{-4}$. Production of ^8Li is also observed with a probability of $(8 \pm 4) \times 10^{-3}$ per stopped pion. (auth)

4862 THE $^6Li(\gamma,t)^3He$ REACTION, DIPOLE SUM RULES AND CLUSTER STRUCTURE OF ^6Li. Shin, Y. M.; Skopik, D. M.; Murphy, J. J. (Saskatchewan Univ., Saskatoon (Canada). Saskatchewan Accelerator Lab.). Phys. Lett., B; 55: No. 3, 297-300(17 Feb 1975).

The reaction $^6Li(\gamma,t)^3He$ has been studied from E_γ = 18 to 70 MeV by electrodisintegration. Various dipole sum rules obtained from the experimental results are consistent with the $^3H + ^3He$ cluster description of ^6Li. (auth)

4863 RESTRICTIONS FOR ASYMMETRY AND POLARIZATIONS OF RECOIL IN MUON CAPTURE. Bernabeu, J. (European Organization for Nuclear Research, Geneva (Switzerland)). Phys. Lett., B; 55: No. 3, 313-317(17 Feb 1975).

Using the helicity formalism, we discuss muon capture by targets of spin zero. Owing to the definite neutrino helicity, three independent observables define a complete experiment. The precise relation between asymmetry α and longitudinal polarization P_L of recoil, $\alpha = 1 + 2jP_L$, comes only from rotational invariance. When time-reversal invariance is inserted, there is an additional restriction between the average polarization P_{av} and the longitudinal polarization P_L. On the basis of the experimental result $P_{av} = 0.43 \pm 0.10$ for ^{12}C, $P_L = -(0.99^{+0.0}_{-0.01})$ is predicted. (auth)

4864 THE REACTION $^7Li(d,n_0)^8Be$ WITH POLARIZED 800 keV DEUTERONS. von Moellendorff, U. Basel; Univ. Basel (1971). 23p. (In German). INIS.

Thesis.

The analyzing power of the $^7Li(d,n_0)^8Be$ reaction for the vector and tensor polarizations of an 800-keV deuteron beam was measured at angles between 0° and 160°, by using a thick natural target. An analysis of the data in terms of (l, s, J) matrix elements shows that the reaction cannot be described by one single dominant intermediate state. Rather, two strongly interfering states show up with spins and parities $J^\pi = \frac{3}{2}^+$ and $J^\pi = \frac{5}{2}^-$. One of these states probably corresponds to the 17.28-MeV excited ^9Be level. For the other one the 16.67-MeV level might be responsible. The occurrence of these overlapping states contradicts older results but was also found in a recent investigation of the $^7Li(d,\alpha)^5He$ reaction. (auth)

4865 COMPOUND-EXCITATION OF ^{18}F BY THE REACTIONS $^{14}N(\alpha,n)^{17}F$ AND $^{16}O(d,n)^{17}F$. Schmidt, W. Cologne; Univ. Cologne (1972). 61p. (In German). INIS.

Thesis.

With a 180°-coincidence spectrometer the total cross sections of the reactions $^{14}N(\alpha,n)^{17}F$ in the energy range from 6 to 19.75 MeV, and of $^{16}O(d,n)^{17}F$ from 1.78 to 15.78 MeV were measured in steps of 50 keV. The excitation functions oscillate with energy, they show so-called Ericson-fluctuations. The structure of the curves were analyzed within the framework of the statistical model. To estimate the compound part of the total reaction mechanism, a Hauser–Feshbach calculation was performed, and the results were compared with the experimentally determined cross sections. (GE)

4866 TWO-PARTICLE LADDER DIAGRAMS AND DOUBLE-COUNTING IN EFFECTIVE INTERACTION CALCULATIONS. Barrett, B. R. (Arizona Univ., Tucson (USA). Dept. of Physics); Kirson, M. W. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Phys. Lett., B; 55: No. 2, 129-133 (3 Feb 1975).

It is shown that including the two-particle ladder diagrams, computed with the Barrett, Hewitt, McCarthy G matrix elements at a starting energy of 47 MeV and for intermediate excitations of $2\hbar\Omega$, in the perturbation expansion for the effective two-body interaction in mass-18 nuclei involves a double-counting of roughly 42%. It is argued by comparison that the double-counting should be roughly the same when the Kuo G matrix elements are used. (auth)

4867 THE $T = T_z + 2$ GDR AND THE DIPOLE STATES OF THE A = 6 AND 14 NUCLEI. Vergados, J. D. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 2, 271-288(24 Feb 1975).

The isospin properties of the giant dipole resonance (GDR) built on states with isospin $T = T_z + 1$ are discussed. Results of a shell-model calculation with realistic interactions for dipole transitions to various low lying states in ^6Li, ^6He, ^{14}N and ^{14}C are presented. The $T = T_z + 2$ component of the GDR in ^{14}N decaying to the 0^+ T = 1 state is predicted at the surprisingly low energy E_x = 26.0 MeV. (auth)

4868 THE GENERATOR COORDINATE METHOD AS AN APPROXIMATION TO THE EXACT DIAGONALIZATION IN A GIVEN MODEL SPACE. Mankoc-Borstnik, N.; Rosina, M. (Ljubljana Univ. (Yugoslavia). Fakultet za Naravoslovje in Tehnologijo); Mihailovic, M. V. (Oxford Univ. (UK). Dept. of Theoretical Physics). Nucl. Phys., A; 239: No. 2, 321-332(24 Feb 1975).

The low lying states of the nuclei ^{16}O and ^{20}Ne are calculated with the generator coordinate method. For ^{16}O two generator coordinates are used, which are related to the quadrupole and to the octupole deformation of the single-particle potential. For ^{20}Ne the generator coordinates are related to the parameters

β and D of the Nilsson potential. In both cases six pairs of coordinate values are chosen. The results are compared with those of the complete diagonalization. The agreement is, for both cases, better than 0.5 MeV for most low lying states. (auth)

4869 ENERGY DEPENDENCE OF THE CROSS SECTIONS FOR THE d + ^{10}B → 3α AND THE p + ^{11}B → 3α REACTIONS. Valkovic, V.; Miljanic, D.; Liebert, R. B.; Phillips, G. C. (Rice Univ., Houston, Tex. (USA). Bonner Nuclear Labs.). Nucl. Phys., A; 239: No. 2, 260-270(24 Feb 1975).

The excitation function for the ^{10}B(d,α)^{8}Be$_{g.s.}$ reaction was measured with both single counter and coincidence techniques in the bombarding energy range 2.5 to 4.5 MeV. The excitation function for the ^{11}B(p,α)^{8}Be*(2.9 MeV) reaction was measured in the bombarding energy range 7.5 to 10.5 MeV. The observed structures in the excitation functions were compared with the prediction of a simple theoretical model involving pole and triangle graphs. (auth)

4870 GIANT RESONANCE EFFECTS IN THE ANALYZING POWER FROM INELASTIC PROTON SCATTERING. Smith, R.; Amos, K. (Melbourne Univ., Parkville (Australia). School of Physics). Phys. Lett., B; 55: No. 2, 162-166(3 Feb 1975).

A simultaneous analysis of the analyzing power and differential cross section for the inelastic scattering of 30.4-MeV protons to the 2$^-$(8.88 MeV) state in ^{16}O confirms the importance of two-step components in the reaction mechanism. These important two step processes are those in which giant multipole resonances of the target are excited. (auth)

4871 ELASTIC SCATTERING OF ^{16}O ON ^{12}C IN THE FRAMEWORK OF TWO-CENTER MODEL. Cherdantsev, P. A.; Chernov, I. P.; Vershinin, G. A. (Research Institute for Nuclear Physics, Tomsk, USSR). Phys. Lett., B; 55: No. 2, 137-140(3 Feb 1975).

The model for the description experimentally observed intermediate structure and the sharp backward rise of the cross sections of elastic ^{12}C + ^{16}O scattering is proposed. The deformation and interior structure of the colliding nuclei are taken into account. The qualitative agreements for elastic scattering cross sections are obtained. (auth)

4872 THE REACTION ^{11}B(γ,p)^{10}Be* AT INTERMEDIATE ENERGIES. Adler, J. O.; Jonsson, G. G.; Lindgren, K. (Tekniska Hoegskolan, Lund (Sweden). Institutionen foer Kaernfysik). Nucl. Phys., A; 239: No. 3, 440-444(3 Mar 1975).

The yield of the reaction ^{11}B(γ,p)^{10}Be* has been measured for bremsstrahlung end-point energies between 100 and 800 MeV by observing de-excitation γ-rays from the first excited state. The number of nucleons available for the reaction is determined and compared to theoretical predictions for proton pick-up on ^{11}B. (auth)

4873 QUASIFREE ^{5}He + ^{3}He → α + α REACTION PROCESS IN THE ^{9}Be(^{3}He,$\alpha\alpha$)^{4}He REACTION AT E(^{3}He) = 4.0MeV. Kasagi, J.; Nakagawa, T.; Sekine, N.; Tohei, T. (Tohoku Univ., Sendai (Japan). Dept. of Physics); Ueno, H. (Yamagata Univ. (Japan)). Nucl. Phys., A; 239: No. 2, 233-241(24 Feb 1975).

The quasifree ^{5}He + ^{3}He → α + α reaction process was observed in the ^{9}Be(^{3}He,$\alpha\alpha$)^{4}He reaction at E(^{3}He) = 4.0 MeV. The momentum distribution between the ^{5}He and α-particle clusters in ^{9}Be was extracted. The result shows that the ^{5}He-α system in ^{9}Be is mainly in an S-state which is the same conclusion as obtained from the (p,pα) and (α,2α) reactions. The deduced momentum distribution is somewhat narrower compared with the (p,pα) results. The angular distribution of the quasi ^{5}He + ^{3}He → α + α reaction was also deduced. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 3592, 4578, 4811, 4819, 4820, 4825, 4835, 4846, 4854, 4971, 4997, 5039, 5053, 5140, 5166, 5167, and 5201.

4874 (CEA-N-1700, pp 8-11) ^{6}Li AND ^{7}Li REACTIONS WITH ^{20}Ne. Foti, A. (Univ., Catania, Italy); Girardin, C.; Lepareux, M.; Pappalardo, G.; Saunier, N.; Strazzeri, A.; Wery, M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

The (^{7}Li,t) and (^{6}Li,d) reactions on ^{20}Ne are studied. The spectra of these reactions, observed at 30 MeV incident energy, present intense peaks up to 23 MeV excitation energy of ^{24}Mg. A comparison is done between the corresponding excitation energies and those of the high spin levels excited in the (^{16}O,α) and (^{12}C,α) reactions. (auth)

4875 (CEA-N-1700, pp 27-29) EXCITATION FUNCTIONS FOR ^{16}O ELASTIC AND INELASTIC SCATTERING ON ^{24}Mg. Badawy, I. (Cairo Univ.); Berthier, B.; Charles, P.; Fernadez, B.; Gastebois, J.; Lee, S. M.; Mittig, W. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

Excitation functions of ^{24}Mg(^{16}O, ^{16}O)^{24}Mg* were studied between 25 and 64 MeV. Scattering to the ground state and the 2$^+$ (1.37 MeV) state was analyzed in terms of coupled channel calculations. While agreement is good for inelastic scattering at lower energies (≤ 40 MeV) and for the forward angle (58°) at higher energies and backward angles (110°) predicted cross sections are a factor 10 too low suggesting that another reaction mechanism or neglected terms in the heavy ion interaction potential begin to play an important role. (auth)

4876 (CEA-N-1700, pp 29-31) STATES IN ^{24}Mg CONTINUUM FROM ^{23}Na(p,α) AND ^{20}Ne(α,α') REACTIONS. Ballini, R.; Cindro, N.; Delaunay, J.; Foti, A.; Fouan, J. P.; Kalbach, C.; Lepareux, M.; Saunier, N. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

Resonances in ^{24}Mg observed in the ^{12}C + ^{12}C interaction were studied by means of the ^{23}Na(p,α) and ^{20}Ne(α,α') reactions. The results are not inconsistent with an interpretation in terms of simple alpha-like structures in the continuum of ^{24}Mg. (auth)

4877 (CONF-731229-P16A, pp 87-99) NUCLEAR STRUCTURE INFORMATION FROM THE SINGLE NUCLEON TRANSFER REACTIONS. Puttaswamy, N. G. (Bangalore Univ., India). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27-31, 1973. Volume 16A.

Single-nucleon-transfer reactions (stripping and pickup reactions) are being studied with various projectiles of energy 20 to 50 MeV. A study of the energy spectrum and angular distribution of the outgoing particles can give valuable information about the properties of the energy levels of the residual nucleus. For example, one can determine the position of the energy levels and the angular momentum of the transferred nucleon which, in turn, can be used to predict the spin-parity of the levels. A comparison of the experimental angular distribution with that obtained from a DWBA (distorted-wave Born approximation) calculation will yield the spectroscopic factor, which tells how good is the representation of the residual nucleus as the target (in a stripping reaction) plus a single particle in the shell-model state. Experimental data on selected stripping and pickup reactions for sd-shell nuclei are used to extract spectroscopic factors, sum rules, and single-particle strengths. The results are compared with available theoretical calculations. (5 figures, 4 tables) (auth)

4878 (CRN/PN-74-36) LEVEL STRUCTURE OF ^{29}Al FROM ANGULAR CORRELATIONS AND LINEAR POLARIZATIONS MEASUREMENTS IN THE ^{26}Mg(α,pγ)^{29}Al REACTION. Beck, F. A.; Byrski, T.; Engelstein, P.; Vivien, J. P. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Centre de Recherches Nucleaires; Strasbourg-1 Univ., 67 (France)). 1974. 23p. Dep. NTIS (US Sales Only) $4.00.

The decay scheme of ^{29}Al was investigated with the ^{26}Mg(α,γ)^{29}Al reaction by simultaneous measurements of p-γ angular correlations and p-γ linear polarizations with a three-detector Ge(Li) Compton polarimeter. Spins and parities of the 1.76-, 2.23-, 3.19-, 3.58-, and 4.22-MeV levels were unambiguously fixed to, respectively, 7/2$^+$, 3/2$^+$, 5/2$^+$, 9/2$^+$, and 5/2$^+$. Results are compared to previous calculations in the Nilsson Model and in the shell model framework. (4 figures, 3 tables) (auth)

4879 (RLO-1388-258, pp 101-102) ENTRANCE CHANNEL EFFECTS IN THE ^{32}S SYSTEM: COMPARISON OF ^{12}C + ^{20}Ne AND ^{16}O + ^{16}O ELASTIC SCATTERING. Vandenbosch, R.; Webb, M. P.; Zisman, M. S. Jun 1974.

In annual report, 1974.

4880 (RLO-1388-258, pp 108-112) HEAVY ION ELASTIC SCATTERING FROM sd-SHELL NUCLEI. Chan, Y. D.; Cramer, J. G.; Cuengco, B.; DeVries, R. M.; Liu, K. L.; Zisman, M. S. Jun 1974.

In annual report, 1974.

4881 (RLO-1388-258, pp 124-128) SEARCH FOR ΔT = 2 γ-DECAYS OF THE TWO LOWEST T = 2 STATES IN ^{20}Ne. Adelberger, E. G.; Cooper, M. D.; Marrs, R. E.; Snover, K. A. Jun 1974.

In annual report, 1974.

4882 (RLO-1388-258, pp 129-131) GAMMA DECAY OF UNBOUND STATES IN ^{24}Mg: SEARCH FOR THE 10$^+$ MEMBER OF THE GROUND STATE ROTATIONAL BAND. Snover, K. A.; Tape, J. W.; Zisman, M. S. Jun 1974.

In annual report, 1974.
A preliminary scan of the data yielded negative results. (RWR)

4883 (RLO-1388-258, pp 201-205) RADIATIVE PROTON CAPTURE INTO THE GIANT DIPOLE RESONANCE OF ^{29}P. Berghofer, D. (Univ. of British Columbia, Vancouver); Ebisawa, K.; Hasinoff, M.; Lim, S. T.; Measday, D. Jun 1974.
In annual report, 1974.

4884 STUDY OF ELECTRO-MAGNETIC TRANSITIONS IN ^{38}Ca. Hagen, E. C. Durham, NC; Duke Univ. (1974). 85p. University Microfilms Order No. 75-2382.
Thesis (Ph. D.).
The Doppler shift attenuation method (DSAM) has been used to measure the mean lifetimes of low-lying excited states of ^{38}Ca. The levels were populated by the ^{36}Ar(^{3}He,ngamma)^{38}Ca reaction at ^{3}He bombarding energies of 9.0, 10.0, and 10.5 MeV. Both enriched (99.6 percent) ^{36}Ar gas and solid targets were used. The solid target was a tantalum foil with ^{36}Ar embedded in it. Precise energies for the first six levels have been determined. A doublet at 3.7 MeV was resolved as a J/sup pi/ equals 3$^-$ state at 3.703 MeV and a J/sup pi/ equals 2$^+$ state at 3.684 MeV. The lifetimes determined in this study are 98^{+44}/sub - 40/ fs, 27^{+17}/sub - 11/ ps, less than 8 fs, 225^{+100}/sub - 85/ fs and 35 +- 17 fs for the levels at 2.213, 3.084, 3.684, 3.703, and 4.384 MeV. The lifetime of the level at 4.193 MeV was not determined. The experimental level scheme is compared with other A equals 38 nuclei and with a calculation performed with the Oak Ridge-Rochester shell model code. The model used (s/sub 1/2/)/sup j/(d/sub 3/2/)/sup k/(f/sub 7/2/)/sup l/(p/sub 3/2/)/sup m/ configurations with l + m less than or equal to 2, j greater than or equal to 2 and k greater than or equal to 4. (Diss. Abstr. Int., B)

4885 PROPERTIES OF GAMMA-RAY TRANSITIONS IN ^{33}S AND ^{35}S. Hutton, J. D. Durham, NC; Duke Univ. (1974). 102p. University Microfilms Order No. 75-2388.
Thesis (Ph. D.)
The properties of gamma-ray decays of low-lying levels in ^{33}S and ^{35}S have been studied via the ^{32,34}S(d Vector,pgamma)^{33,35}S reactions. Multipole mixing ratios have been measured by gamma-ray transitions between bound levels with particle-gamma-ray angular correlations and Method II of Litherland and Ferguson. This is one of the first uses of a very powerful polarized beam technique developed and first used at TUNL which allows the extraction of information not previously possible with the (d,pgamma) reaction. A tensor polarized deuteron beam from the TUNL Lamb-shift polarized ion source accelerated to 4.72 MeV with the TUNL FN Tandem accelerator was used to bombard 80 mu g/cm^2 natural sulfur and enriched (90 percent) ^{34}S targets prepared by evaporating sulfur onto a gold foil then evaporating goid on top. Four 7.6 x 7.6 cm NaI(Tl) scintillation detectors situated at angles between 30 and 90^0 to the beam detected gamma-rays in coincidence with protons detected at 180^0 in a 2 mm thick annular surface barrier detector. Results for ^{33}S are compared with previous results with which they agree well, and with current shell-model theory. Mixing ratios have been measured for many levels in ^{35}S as follows (E/sub x/:J/sup pi/:delta):(1991:7/2$^-$:0.042), (2348:3/2$^-$:0.044), (2718:(3/2$^+$):0.065,-5.4), (2718:(5/2$^+$):-0.36,-7.1), (2935:(3/2):0.34), (2935:(5/2):0.086), (3802:3/2$^-$:0.18,-8). (Diss. Abstr. Int., B)

4886 NOTE ON THE POSSIBLE 4$^+$ ANALOGUE–ANTI-ANALOGUE STATES IN ^{28}Si. Rahman, M. A. (Atomic Energy Centre, Dacca, Pakistan); Awal, M. A.; Rahman, M.; Gupta, H. M. S.; Gupta, S. K. Lett. Nuovo Cim.; 12: No. 9, 290-292 (1 Mar 1975).
The properties of the 14.007 MeV resonance in ^{28}Si as obtained from the measurement of the angular distribution of de-exciting gamma rays from the reaction ^{27}Al(p,γ_0)^{28}Si are discussed. The most likely configuration of the 14.007 MeV level (J = 4$^+$, T = 1) is found to be $[(d_{5/2})^{-1}(d_{3/2})^1]$ or $[(d_{5/2})^{-1}(d_{5/2})^1]$, the former being preferred due to the high excitation energy of the parent level. (1 figure, 1 table) (SDF)

4887 SPIN–FLIP IN INELASTIC SCATTERING OF PROTONS BY ^{24}Mg. Golubev, S. L.; Kurepin, A. B.; Likhosherstov, V. N.; Osetinskii, G. M.; Faruk, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 251-259(Feb 1975). (In Russian).
The energy and angular distributions of the spin–flip probability of protons and of the differential cross section of the proton inelastic scattering are measured near the resonance energies 2.41 and 4.02 MeV in the reaction ^{24}Mg(p,p'γ)^{24}Mg. The spin–flip and inelastic angular distributions are isotropic at 2.41 MeV. In the vicinity of this resonance the spin–flip probability W($\theta_{p'}$) is energy independent and equals 0.175 ± 0.026. At 4.02 MeV the differential cross section and W($\theta_{p'}$) are not isotropic but symmetrical relative to 90° in the c.m.s. The probability W($\theta_{p'} = \pi/2$) is energy independent and equals 0.35 ± 0.04. It is shown that the spin–flip probability in the vicinity of the isolated Breit–Wigner resonance is energy independent if there is no direct process. In the case of the S wave resonance in the outgoing channel the quantity W($\theta_{p'}$) is determined only by the reaction kinematics and measurement of W($\theta_{p'}$) may be a method to establish the spin of the compound nucleus resonance. (auth)

4888 REACTIONS (^{7}Li, ^{7}Li), (^{7}Li, ^{6}Li), AND (^{7}Li, ^{6}He) ON THE DEFORMED TARGET ^{24}Mg AT $E_{^7Li}$ = 34 MeV. Moore, G.E.; Kemper, K.W.; Charlton, L.A. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 11: No. 4, 1099-1110 (Apr 1975).
Angular distributions for the single-nucleon-transfer reactions ^{24}Mg(^{7}Li, ^{6}Li)^{25}Mg and ^{24}Mg(^{7}Li, ^{6}He)^{25}Al have been measured to study the effects of target deformation on heavy-ion transfer reactions at $E_{^7Li}$ = 34 MeV. Elastic and inelastic scattering angular distributions have also been measured for ^{7}Li + ^{24}Mg at the same energy. Optical model fits to the elastic scattering data were good in the diffraction region, but they overestimated the cross section at forward angles. Coupled-channels calculations, which coupled the ground and first excited states of ^{24}Mg with ^{7}Li in its ground state, yielded deformation lengths that are in agreement with those obtained from light-ion scattering measurements. The single-nucleon-transfer data were compared to exact finite-range distorted-wave Born-approximation calculations. While the extracted spectroscopic factors are in reasonable agreement with those obtained from light-ion works, the calculations are out of phase with the data. Parameter variations by as much as 20% did not resolve this problem. The cross sections for transitions to the *j*-forbidden 7/2$^+$ (1.61 MeV) states in ^{25}Al and ^{25}Mg were smaller relative to the allowed transitions than observed in corresponding light-ion single-nucleon-transfer reactions. (auth)

4889 GAMMA RAY LINEAR POLARIZATION MEASUREMENTS FOR ^{29}Al. Williams, J.R.; Nelson, R.O.; Gould, C.R.; Tilley, D.R. (North Carolina State University, Raleigh, North Carolina 27607 and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27706). Phys. Rev. C 11: No. 4, 1111-1116 (Apr 1975).
Levels of ^{29}Al were populated with the ^{26}Mg(α,p)^{29}Al reaction at E_α = 11.26 MeV. The linear polarizations of γ rays emitted in the decays of the 1.40-, 1.75-, 2.22-, and 2.87-MeV levels were measured. The polarization measurements are consistent with known spin-parity assignments for the 1.40- and 2.87-MeV levels, respectively. When combined with previously available information, they indicate an assignment of 3/2$^+$ for the 2.22-MeV level and 7/2$^+$ (3/2$^+$) for the 1.75-MeV level. (auth)

4890 NEUTRON RESONANCE SPECTROSCOPY: ALUMINUM. Singh, U.N.; Rainwater, J.; Liou, H.I.; Hacken, G. (Columbia University, New York, New York 10027); Garg, J.B. Phys. Rev. C 11: No. 4, 1117-1121 (Apr 1975).
The results are presented for high-resolution neutron time-of-flight measurements on ^{27}Al from 4 to 420 keV. The *R*-matrix multilevel shape analysis was used to obtain the resonance parameters for seven levels to 220 keV. We determined the strength functions as $10^4 S_0 = (3.25_{-1.7}{}^{+4.5})$ and $10^4 S_1 = (1.8_{-1.1}{}^{+3.5})$. A channel radius of 4.2 fm was used in the calculation of *p*-strength function. The (E_0, *l*, *J*, Γ_n) choices were (5.895, 1, 1, 0.017), (34.59, 0, 2, 3.0), (85.69, 0, 3, 11.0), (119.6, 1, 2, 3.6), (142.0, 0, 3, 19.0), (158.2, 1, 3, 3.2), and (202.2, 0, 2, 14.5), where E_0 and Γ_n are in keV. (auth)

4891 GAMMA-RAY STUDIES AT THE 2876- AND 2879-keV RESONANCES IN ^{27}Al + *p*. Neal, G.F.; Chagnon, P.R. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 11: No. 4, 1461-1463 (Apr 1975).
The 6$^-$ assignment to the 14.358-MeV level of ^{28}Si and the concomitant *M*1 character of the 14.358 → 11.577-MeV transition have been made rigorous by a linear-polarization measurement of this radiation at the 2876-keV resonance in ^{27}Al + *p*. The spin and parity of the 2879-keV resonance, E_x = 14.361 MeV, are restricted to 2$^+$, 5, or 6$^+$, with 2$^+$ preferred. (auth)

4892 DIRECT ELECTRON-POSITRON PAIR PRODUCTION BY 200-GeV NEGATIVE PIONS. Fortney, L.R.; Goshaw, A.T.; Lamsa, J.W.; Loos, J.S.; Niemi, D.A.; Robertson, W.J.; Walker, W.D. (Physics Department, Duke University, Durham, North Carolina 27706). Phys. Rev. Lett. 34: No. 14, 907-910 (7 Apr 1975).
We have studied direct electron-positron pair production by the collision of 200-GeV π^- mesons with a neon target. The data consist of 622 direct pairs with momenta ranging from 10 MeV/*c* to 7.5 GeV/*c*. We have measured the total production rate to an accuracy of 10% and studied the relevant momentum and electron-positron momentum partition spectra. In contrast to several recent experiments, we find excellent agreement with the predictions of quantum electrodynamic calculations. (auth)

4893 NEW LEVELS OF THE ^{28}Al NUCLEUS. Solin, L. M.; Nemilov, Yu. A.; Litvin, V. F.; Kuz'min, V. N.; Zherebtsova, K. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2211-2212(Oct 1974). (In Russian).

The proton energy spectrum from the $^{27}Al(d,p)^{28}Al$ reaction, corresponding to the excitation energies from 5.7 to 7.0 MeV for ^{28}Al, was measured. The energy spectrum obtained is reported. New levels were detected at 5812, 6455, 6496, 6517, 6675, 6775, 6793, and 6813 keV. (2 figures) (JSR)

4894 EXOTIC REACTIONS IN THE LIGHT ELEMENTS. Cerny, J. (Univ. of California, Berkeley). pp 483-499 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Recent in-beam experiments with heavy ions leading to mass measurements and spectroscopic studies of light nuclei very far from the region of beta stability are reviewed. The detection of resonance particles as low-yield reaction products is discussed first. Heavy-ion reactions producing multineutron final states are then taken up. Energy spectra are shown for the $^{7}Li(^{7}Li,^{11}B)T$, $^{7}Li(^{7}Li,^{11}C)3n$, and $^{7}Li(^{7}Li,^{10}C)4n$ reactions at 79.6 MeV. Several excited states were seen in the $(^{7}Li,^{11}B)$ reaction, but no structure was visible in the $(^{7}Li,^{11}C)$ reaction. Upper limits for the production of trineutrons and tetraneutrons in these experiments were 70 and 30 nb, respectively. Other multinucleon transfer reactions are then considered, with emphasis on two-proton-pickup reactions and exotic rearrangement reactions. Energy spectra are shown for the following reactions: $^{48}Ca(^{6}Li,^{8}B)^{46}Ar$ at 80 MeV; $(^{6}Li,^{8}B)$ on ^{11}B, ^{9}Be, and ^{12}C at 80 MeV; $(^{11}B,^{8}B)$ on ^{26}Mg and ^{28}Si at 86 MeV; $^{26}Mg(alpha,^{8}He)^{22}Mg$ at 110 MeV; (alpha,^{8}He) on ^{12}C and ^{24}Mg at 156 MeV; $^{14}C(^{18}O,^{12}Be)^{20}Ne$ at 88.7 MeV; $^{26}Mg(^{7}Li,^{8}B)^{25}Ne$ at 78.9 MeV; and $^{9}Be(^{9}Be,^{8}B)^{10}Li$ at 120 MeV. Finally, predictions made by using the shell model and the relations of Garvey et al. are compared with measured masses for T/sub Z/equals 5/2 nuclei in the 2s--1d shell. (19 figures) (RWR)

4895 ELASTIC AND INELASTIC SCATTERING OF α PARTICLES AT LARGE ANGLES ON NUCLEI IN THE 2s–1d SHELL. Antropov, A. E.; Vasil'ev, S. I.; Zarubin, P. P.; Orlov, B. N. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2175-2185(Oct 1974). (In Russian).

Experimental data on the anomalous scattering of α particles, determined from measurements on the elastic and inelastic scattering of 24.2-MeV α particles on $^{24,25,26}Mg$, $^{32,34}S$, and ^{31}P, were reported. The excitation functions of the elastic and inelastic scattering on ^{32}S were determined in the energy interval from 18.8 to 24.2 MeV. The experimental results were compared with literature data on other nuclei and with some proposed mechanisms of anomalous scattering. (7 figures, 1 table) (JSR)

4896 MONTE CARLO ANALYSIS OF DOPPLER-SHIFT ATTENUATED LINE SHAPES FOR NUCLEAR LIFETIMES. Sargent, B. W.; Hanson, W. G.; Puhach, P. A.; Sinclair, D. (Queen's Univ., Kingston, Ontario (Canada). Dept. of Physics). Nucl. Instrum. Methods; 124: No. 1, 265-279(15 Feb 1975).

Lifetimes of the 4414 keV 4^+ and 4441 keV 2^+ excited states in ^{36}Ar populated in $^{35}Cl(p,\gamma)^{36}Ar$ reactions were derived by a Monte Carlo analysis of the Doppler-shift attenuated line shapes measured in a γ-ray spectrometer at angles 0° and 90° to the proton beam. The Monte Carlo simulation of the slowing down and scattering of the ^{36}Ar ions in the $Ba^{35}Cl_2$ target was based on the formalism by Lindhard and collaborators. Lifetimes of (129 ± 8) and (153 ± 6) fs were derived for the 4414 and 4441 keV states, respectively. The errors quoted do not include uncertainties in the electronic and nuclear stopping powers. A detailed account of the treatment of the nuclear data is given. (auth)

4897 ELECTROEXCITATION OF ROTATIONAL BANDS IN ^{25}Mg. Okazaki, Y.; Hayakawa, K.; Nakahara, K.; Oyamada, M.; Terasawa, T. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science); Saito, H. (Tohoku Univ., Sendai (Japan). Dept. of Physics). Phys. Lett., B; 55: No. 4, 373-376(3 Mar 1975).

The electric quadrupole and hexadecapole excitations of ^{25}Mg have been investigated by inelastic electron scattering. The measured C2 and C4 form factors are compared with the strong-coupling model; good agreement is obtained. (auth)

4898 ENERGY LEVELS OF ^{31}S. Davidson, J. M.; Hutcheon, D. A.; Gill, D. R.; Taylor, T.; Sheppard, D. M.; Olsen, W. C. (Alberta Univ., Edmonton (Canada). Nuclear Research Centre). Nucl. Phys., A; 240: No. 2, 253-262(17 Mar 1975).

The level structure of ^{31}S was investigated using the reactions $^{29}Si(^{3}He,n)^{31}S$, $^{29}Si(^{3}He,n\gamma)^{31}S$, and $^{29}Si(^{3}He,n\gamma\gamma)^{31}S$ at 6.5 MeV. Previously unreported ^{31}S levels were identified in neutron time-of-flight spectra at 6277, 6796, 6921, 7112, 7445, 7850, 7985, 8183, 8362 and 8453 keV excitation (all ±25 keV). Angular distribution measurements confirm $J^\pi = 1/2^+$ assignments for the ground state and for states at 3079, 5151 and 7006 keV. The second $T = 3/2$ state in ^{31}S was identified at 7006 ± 25 keV excitation. The ground-state mass of ^{31}Cl was calculated from the isobaric multiplet mass equation to be $M - A = -6935 \pm 45$ keV. In γ-ray coincidence measurements, precise values of excitation energy were determined for ^{31}S levels at 1248.9 ± 0.2, 2235.6 ± 0.4, 3079.0 ± 1.1, 3285.5 ± 0.5, and 3351.1 ± 0.6 keV. (auth)

4899 (^{3}He,t) REACTIONS WITH T = 1 NUCLEI OF THE s,d-SHELL. Duhm, H. H. Heidelberg; Univ. Heidelberg (1970). 48p. (In German). INIS.

Thesis.

The (^{3}He,t) angular distribution of the nuclei ^{18}O, ^{22}Ne and ^{26}Mg was investigated in order to verify the angular momentum transfer for states of unnatural parity in the s,d-shell. The microscopic DWBA theory with pure spin–isospin flip terms was shown to be incorrect. In the case of tensor forces, the angular distributions seem to be interpreted correctly. From the (^{3}He,t) reactions the energy levels, spin and parity of ^{18}O, ^{22}Ne and ^{26}Mg were determined. (GE)

4900 AN OPTICAL MODEL ANALYSIS OF ELASTIC SCATTERING OF DEUTERONS ON ^{28}Si AT 1.9 TO 2.5 MeV. Bondouk, I. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Nuclear Physics). Atomkernenergie; 24: No. 4, 283 (1974).

The differential cross-sections for the elastic scattering of deuterons by ^{28}Si have been analyzed in terms of the optical model using surface absorption. Good fits were obtained with optical model potentials of real well depths in the region of 100 MeV. (auth)

4901 STRUCTURE IN THE ^{31}P PHOTONEUTRON CROSS SECTION. Devos, J.; Carchon, R.; Ferdinande, H.; van de Vyer, R. (Ghent Rijksuniversiteit (Belgium). Lab. voor Kernfysika). Z. Phys.; 271: No. 4, 391-397(Dec 1974).

The $^{31}P(\gamma,xn)$ cross section was measured from threshold up to 25 MeV, using the bremsstrahlung photon beam from the 35 MeV linac. Several analysis procedures were used to compute the photoneutron cross section from the experimental yield curve. Our results are compared with other bremsstrahlung measurements and with the quasi-monoenergetic photon work by the Saclay group. The leading edge of the giant resonance shows an extremely rich fine structure which seems to be characteristic for nuclei in the 1d–2s shell. (auth)

4902 ALLOWED ELECTRON-CAPTURE BRANCHES IN THE DECAY OF ^{34m}Cl. van Driel, M. A.; Klijnman, H.; Engelbertink, G. A. P.; Eggenhuisen, H. H.; Hermans, J. A. J. (Rijksuniversiteit Utrecht (Netherlands). Fysisch Lab.). Nucl. Phys., A; 240: No. 1, 98-108(10 Mar 1975).

The decay of ^{34m}Cl was studied with 36 and 100 cm^3 Ge(Li) detectors and with a high resolution large volume Ge(Li)-NaI(Tl) Compton-suppression spectrometer. The ^{34m}Cl activity was produced with the reaction $^{24}Mg(^{12}C,pn)^{34}Cl$ at $E(^{12}C) = 35$ MeV by bombarding thick natural Mg targets. The half-life was measured to be $\tau_{\frac{1}{2}} = 32.06 \pm 0.08$ min. Nine γ-ray transitions were observed including four γ-rays not seen previously. The measured γ-ray intensities determine new electron-capture branches of (0.030 ± 0.006)% and (0.032 ± 0.003)% to ^{34}S levels at 4.69 and 4.88 MeV with log ft values of 5.48 ± 0.08 and 5.26 ± 0.04, respectively. These log ft values imply allowed transitions and are consistent with the known J^π values of $J^\pi = 4^+$ and 3^+ of the 4.69 and 4.88 MeV levels, respectively. A lower limit of log ft >6.9 is obtained for the allowed electron-capture branch to the $J^\pi = 2^+$, 4.89 MeV level. Other previously observed decay branches were confirmed. Since the decay of ^{34m}Cl proceeds (46.9 ± 1.0)% to the ^{34}Cl ground state, the latter decay was studied concurrently; $^{34}Cl(0)$ with $J^\pi = 0^+$, T = 1 decays exclusively to its analog $^{34}S(0)$ and the sum of the intensities of four other allowed branches is less than 1.2×10^{-4} of the intensity of the ground-state branch. The experimental results are compared with recent shell-model calculations performed in a large configuration space. (auth)

4903 A STUDY OF THE NUCLEAR STRUCTURE OF ^{36}Cl WITH THE (p,d) REACTION. Rice, J. A.; Wildenthal, B. H. (Michigan State Univ., East Lansing (USA). Cyclotron Lab.); Freedom, B. M. (South Carolina Univ., Columbia (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 2, 189-208(24 Feb 1975).

The $^{37}Cl(p,d)^{36}Cl$ reaction, at $E_p = 35$ MeV, was employed to study properties of the levels of ^{36}Cl. Excitation energies of levels up to 8.2 MeV were obtained by high resolution magnetic analysis of the emitted deuterons. Angular distributions for the states observed in this span were measured over the angular range $\theta_L = 3$ to 55°. These data were analyzed with the DWBA theory to obtain values of l_n and C^2S_l. The results are compared to the previously existent experimental picture for this nucleus and to current theoretical nuclear structure calculations. (auth)

Nuclear Properties and Reactions, $39 \leq A \leq 58$

Refer also to abstracts 3579, 4818, 4819, 4835, 4842, 4877, 4894, 4929, 4971, 4998, 5001, 5136, 5137, 5143, 5152, 5168, 5185, and 5192.

4904 (BNL-50442) EVALUATION OF THE NEUTRON AND GAMMA-RAY PRODUCTION CROSS-SECTIONS FOR ^{55}Mn. Takahashi, H. (Brookhaven National Lab., Upton, N. Y. (USA)). Nov 1974. Contract AT(30-1)-16. 24p. (ENDF-208). Dep. NTIS $4.25.

The evaluation of neutron and gamma production cross sections for manganese-55 from 1.0 $(10)^{-5}$ eV to 20.0 MeV for ENDF/B-IV is summarized. Included are resonance parameters, neutron cross sections, angular and energy distribution of secondary neutrons, gamma multiplicities and transition probability array, gamma angular and energy distributions, nuclear model calculations, uncertainty estimates of cross sections, and evaluated cross sections. (JFP)

4905 (CEA-N-1700, pp 31-35) STUDY OF THE REACTIONS ^{40}Ca(^{18}O,^{19}F)^{39}K, ^{40}Ca(^{18}O,^{20}Ne)^{38}Ar, AND ^{40}Ca(^{18}O,^{16}O)^{42}Ca. Cunsolo, A. (Univ., Catania, Italy); Lemaire, M. C.; Mermaz, M. C.; Sztark, H. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

^{18}O-induced reactions on ^{40}Ca have been studied at 59.5 MeV. Large cross sections of the one-and two-proton pick-up reactions have been observed. A DWBA analysis of the ^{40}Ca(^{18}O,^{19}F)^{39}K reaction has been performed. (auth)

4906 (CEA-N-1700, pp 103-106) (p,p′) SCATTERING AND NUCLEAR STRUCTURE OF COLLECTIVE STATES. Terrien, Y. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The inelastic scattering of protons from the lowest 2^+ and 3^- levels in ^{40}Ca, Ni, Sn and N = 50 isotopes is analyzed for different energies of the incident protons. The addition of a collective imaginary term to the microscopic real form factor very much improves the agreement between calculated and experimental angular distributions of the cross sections. The variation with energy of the contributions of proton and neutron parts of the transitions is discussed. (auth)

4907 (CEA-N-1700, pp 263-264) STUDY OF PHOTON RESONANCE SCATTERING. Lucas, R.; Fagot, J.; Martinot, M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The monochromatic gamma beam obtained from the Triton reactor has been to investigate photonuclear resonances as various targets in the 5 to 7.5 MeV energy range. The scattered spectrum obtained presents for all the studied targets (except the tantalum one) a 250 keV bump whose intensity is a function of the energy of the studied nucleus. The scattering cross sections have been determined as a function of the energy of the incident beam. (auth)

4908 (KFK-2087) DEFORMATION OF ^{56}Fe FROM 104 MeV α-PARTICLE SCATTERING. Gils, H. J.; Rebel, H.; Nowicki, G.; Ciocanel, A.; Hartmann, D.; Klewe-Nebenius, H.; Wisshak, K. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kernphysik). Dec 1974. 19p. INIS.

6 figs.; 6 tabs.; 33 refs.; with app.

Differential cross sections have been measured for the elastic and inelastic scattering of 104-MeV α-particles from ^{56}Fe. The angular distributions are analyzed in terms of coupled channels on the basis of a symmetric and asymmetric rotator model. The analyses use a semimicroscopic folding procedure and, additionally, in some cases the conventional extended optical model. Deformation parameters, rms radii, multipole moments of nuclear matter, and transition probabilities have been extracted. (auth)

4909 (RLO-1388-258, pp 78-81) ASYMMETRY OF POLARIZED PROTONS INELASTICALLY SCATTERED FROM ^{40}Ca AND ^{48}Ca. Baker, M. P.; Blair, J. S.; Bussoletti, J. E.; Cuengco, B.; Preikschat, E.; Tape, J. W.; Weitkamp, W. G. Jun 1974.

In annual report, 1974.

4910 (RLO-1388-258, pp 112-115) ^{16,18}O ELASTIC SCATTERING FROM ^{58}Ni. Chan, Y. D.; Cramer, J. G.; Cuengco, B.; DeVries, R. M.; Liu, K. L.; Zisman, M. S. Jun 1974.

In annual report, 1974.

4911 (TUNL-13, pp 37-38) SHELL MODEL STUDY OF ^{38}Ca AND ARGON ISOTOPES. Maripuu, S. 1975.

In Triangle Universities Nuclear Laboratory semiannual report, 31 December 1974.

4912 THEORETICAL STUDIES OF SOME 0f-1p SHELL NUCLEI. Fu, C. C. Buffalo; State Univ. of New York (1974). 164p. University Microfilms Order No. 75-1478.

Thesis (Ph. D.).

Employing the realistic matrix elements calculated by Kuo and Brown for the Hamada-Johnston nucleon-nucleon potential, a number of nuclei in the 0f-1p shell are studied within the framework of shell-model and quasiparticle methods. Specifically, shell-model calculations are performed for ^{51}Ti and ^{52}V, which have neutrons and protons in well separated shells outside the closed ^{48}Ca core. In studying ^{51}Ti, in addition to the three-nucleon configurations, some four-particle-one-hole configurations due to the excitation of the core are also included. With ^{40}Ca as a core, shell-model calculations are carried out for ^{43}Sc and ^{43}Ca, and a comparative study of the level structure, transition rates, and spectroscopic strengths of ^{44}Ca is performed, employing the conventional shell model and Kuo-Brown and Clement matrix elements for the Hamada-Johnston and Tabakin interactions, respectively. For the heavier even isotopes of Ca, quasiparticle calculations are performed and the results are compared with the available data. Calculations on the energy levels and transition rates of ^{52}Cr, ^{54}Fe, and ^{56}Ni employing the quasiparticle method, with a ^{48}Ca core, are also carried out. (Diss. Abstr. Int., B)

4913 STATES OF HIGH ANGULAR MOMENTUM IN ^{45}Sc. Bizzeti, P. G.; Bizzeti-Sona, A. M.; Bucciolini, M.; Huber, R.; Kutschera, W.; Morinaga, H.; Ricci, R. A.; Signorini, C. (Technische Univ., Munich). Nuovo Cim.; 26A: No. 1, 25-47(1 Mar 1975).

The previously known level scheme of ^{45}Sc has been extended with the addition of four more high-spin states. The decay of the new level at 3294 keV identifies it as the $^{15}/_{2}^{+}$ member of the K = $^{3}/_{2}$ "quasi-rotational band." The new levels at 3570, 3693 and 5419 keV decay through the negative-parity cascade $^{15}/_{2}^{-} \rightarrow {}^{11}/_{2}^{-} \rightarrow {}^{7}/_{2}^{-}$. A negative parity has been attributed to them, and the spin values $^{17}/_{2}$, $^{19}/_{2}$ ($^{21}/_{2}$ or $^{23}/_{2}$) have been deduced from angular correlations. This set of high-spin states has been discussed in connection with the spherical shell model and the rotational model. (auth)

4914 ELECTROMAGNETIC DECAY OF FRAGMENTED ANALOG STATES IN ^{45}Sc AND ^{63}Cu. Wimpey, J. F. Raleigh, NC; North Carolina State Univ. (1974). 196p. University Microfilms Order No. 75-7697.

Thesis (Ph. D.).

Capture excitation functions were measured for ^{44}Ca(p,gamma)-^{45}Sc from 1.56 to 2.28 MeV and for ^{62}Ni(p, gamma)^{63}Cu from 2.30 to 2.70 MeV. Detailed study of the electromagnetic decay of 57 resonances in ^{45}Sc and 35 resonances in ^{63}Cu was performed using an 80 cm^3 Ge(Li) detector. The experiments were performed with the TUNL 3 MV Van de Graaff accelerator and associated electrostatic analyzer-homogenizer system. The overall energy resolution of the proton beam was about 350 eV. For the 92 resonances studied in detail, absolute partial and total gamma ray widths and inelastic widths were determined. Three fragmented analogs were studied in ^{45}Sc. One analog state was studied in ^{63}Cu, the analog of the 3/2- second excited state of ^{63}Ni. The decay of a number of non-analog (or background) resonances were also studied in both ^{45}Sc and ^{63}Cu. Emphasis was placed on correlations between partial widths in different channels. The strengths of the M1 decay of the 3/2- analogues are as expected for this mass region. Inelastic spectroscopic factors were calculated for the 1/2- and the $1/2^+$ analog states in ^{45}Sc and the 3/2- analog state in ^{63}Cu. (CES)

4915 ANGULAR CORRELATION AND DECAY MODE MEASUREMENTS IN ^{41}Ca USING THE ^{42}Ca(^{3}He, αγ)^{41}Ca REACTION. Tabor, S.L.; Zurmühle, R.W.; Balamuth, D.P. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 11: No. 4, 1089-1098 (Apr 1975).

γ-ray angular correlations have been measured for the 2.010, 2.960, 3.200, 3.526, 3.740, and 4.090 MeV states in ^{41}Ca using the ^{42}Ca(^{3}He, αγ)^{41}Ca reaction. An $E3$ strength of $(1.5_{-0.7}{}^{+0.9})$ Weisskopf units has been determined for the 2.010 → 0 MeV transition from the measured mixing ratio, $\delta = -0.095 \pm 0.022$, and a previous lifetime measurement. The decay scheme and angular correlations imply a spin assignment of $J^\pi = 3/2^+$ for the 3.526 MeV state and strongly suggest that $J^\pi = 3/2^+$ for the 3.740 MeV state and $J^\pi = 5/2^+$ for the 4.090 MeV state. Decay schemes have been measured for four $T = 3/2$ states in ^{41}Ca at 5.814, 6.820, 7.146, and 8.54 MeV. Analog to antianalog state transitions have been observed from the 5.814, 6.820, and 7.146 MeV levels. Such a transition was not reported in a previous study of

the decay of the 5.814 MeV state. The 8.54 MeV state decays primarily by neutron emission but has a 1 to 3% γ-decay branch. In addition, the $^{41}K(^3He, t)^{41}Ca$ reaction was used to verify the $T = 3/2$ assignment for the 5.814 MeV state and the $^{40}Ca(d, p\gamma)^{41}Ca$ reaction was used in the study of the 3.731-3.740 MeV doublet. (auth)

4916 RECOIL-DISTANCE LIFETIME MEASUREMENTS OF ^{49}V LEVELS. Brown, B.A.; Fossan, D.B.; McDonald, J.M.; Snover, K.A. (Department of Physics, State University of New York, Stony Brook, New York 11794). Phys. Rev. C 11: No. 4, 1122-1132 (Apr 1975).

Lifetimes for a number of levels in ^{49}V have been measured using the recoil-distance technique. The experimental results for the mean lifetimes are 8.8 ± 1.4 psec for the 428-keV 5^+ level, 21.6 ± 1.1 psec for the 613-keV 4^+ level, 111 ± 9 psec for the 627-keV 6^+ level, 6.7 ± 1.8 psec for the 1056-keV 3^- level, and 6.5 ± 0.5 psec for the 1099-keV $4^{(-)}$ level. Lifetime limits were measured for other levels. The electromagnetic transition strengths for the positive and negative parity bands are discussed. For the positive parity levels, shell model calculations are carried out assuming wave functions of the form $(\pi f_{7/2})^n (\nu f_{7/2})^{-n}$. Many properties of ^{49}V and surrounding nuclei, particularly for the high-spin states, can be described using the ^{42}Sc effective interaction with effective operators $e_p + e_n = 2$ and $g_p - g_n = 1.29$. For some aspects, however, the effective operator approach within this limited $1f_{7/2}$ model space is not adequate. (auth)

4917 $^{49}Ti(^3He, t)^{49}V$ REACTION. Manthuruthil, J.C.; Poirier, C.P. (Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio 45433); Meyer-Schützmeister, L. Phys. Rev. C 11: No. 4, 1141-1151 (Apr 1975).

The $^{49}Ti(^3He, t)^{49}V$ reaction has been studied at an incident energy of $E_{^3He} = 25$ MeV with a split-pole magnetic spectrograph. A total of 35 levels in ^{49}V have been identified below an excitation energy of 3.05 MeV. Angular distributions have been measured for many levels and analyzed by means of the distorted-wave Born approximation. Definite L-transfer value assignments have been made for many levels. Combining these results with previous work, spin assignments for some levels have been deduced. These results are compared with the predictions of a recent shell-model calculation which assumed a $(\pi f_{7/2})^3 (\nu f_{7/2})^{-3}$ configuration. The isobaric analog of the ^{49}Ti ground state was located at an excitation energy of 3021 ± 10 keV, in good agreement with previous results. (auth)

4918 HIGH-RESOLUTION STUDY OF ^{40}Ca VIA INELASTIC PROTON SCATTERING AT 35 MeV. Nolen, J.A. Jr.; Gleitsmann, R.J. (Physics Department and Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. C 11: No. 4, 1159-1166 (Apr 1975).

Spectra of inelastic proton scattering on ^{40}Ca have been obtained with 4.5 keV resolution at a bombarding energy of 35 MeV. Cross sections for the excitation of several previously unresolved particle-hole states have been measured. Nearly all known energy levels plus nine new levels have been observed up to an excitation energy of 9.3 MeV, slightly above the proton separation energy, and accurate excitation energies have been determined for these states. (auth)

4919 ELECTROEXCITATION OF GIANT MULTIPOLE RESONANCES IN ^{40}Ca. Torizuka, Y.; Itoh, K. (Laboratory of Nuclear Science, Tohoku University, Tomizawa, Sendai, Japan); Shin, Y.M.; Kawazoe, Y.; Matsuzaki, H.; Takeda, G. Phys. Rev. C 11: No. 4, 1174-1178 (Apr 1975).

A study of inelastic electron scattering from ^{40}Ca in the momentum transfer range $q = 0.43$–1.40 fm^{-1} has revealed strong excitations with quadrupole and octupole character which spread over the range of excitation energy $E_x = 10$–25 MeV. For comparison, a simple shell model calculation is made based on the quasielastic model. (auth)

4920 PROPERTIES OF EXCITED STATES OF ^{49}V. Haas, B.; Chevallier, J.; Britz, J. (Centre de Recherches Nucléaires, B.P. 20 Cro, 67037 Strasbourg Cedex, France); Styczen, J. Phys. Rev. C 11: No. 4, 1179-1195 (Apr 1975).

Excitation energies, spins and lifetimes have been measured in ^{49}V employing the reaction $^{46}Ti(\alpha, p\gamma)^{49}V$ at a bombarding energy of 10.6 MeV. Reaction-produced protons were detected in an annular Si counter at an average angle of 171°. Coincident γ-ray spectra were measured with a Ge(Li) detector at angles $120^0 \geq \theta \geq 0$. Two Ge(Li) detectors were used in a γ-γ coincidence experiment. The half-life of the 90.7 keV excited state $T_{1/2} = 0.45$ (3) ns was measured by time-delayed n-γ coincidences employing the reaction $^{49}Ti(p, n\gamma)^{49}V$ at a proton bombarding energy of 2.1 MeV. The results obtained for excitation energies, spins, parities and lifetimes (ps) are: 748.3, $3/2^+$, > 5, < 1000; 1021.6, $11/2^-$, $6.3_{-2.5}{}^{+3.9}$; 1140.9, $5/2^+$, $1.8_{-0.5}{}^{+0.9}$; 1155.4, $9/2^-$, $1.65_{-0.34}{}^{+0.48}$; 1514.4, $5/2^-$, $0.045_{-0.018}{}^{+0.021}$; 1603.1, $7/2^+$, $0.68_{-0.18}{}^{+0.31}$; 1643.1, $1/2^{(-)}$, $3/2^{(-)}$, $5/2^{(-)}$, $0.050_{-0.014}{}^{+0.017}$; 1646.4, $1/2^{(+)}$, $3/2^{(+)}$, $5/2^{(+)}$, > 7.5, < 1000; 1661.4, $3/2^-$, < 0.04; 1994.9, $3/2^+$, $1.34_{-0.43}{}^{+0.080}$; 2178.5, $9/2^+$, $0.80_{-0.40}{}^{+0.70}$; 2182.7, $7/2^-$, < 0.08; 2235.3, $5/2^-$, < 0.05; 2263.3, $15/2^-$, $0.93_{-0.28}{}^{+0.55}$; 2265.2, $3/2^-$, < 0.06; 2309.7, $3/2^-$, < 0.07; 2353.3, $9/2^-$, < 0.07; 2388.2, $5/2^+$, $0.09_{-0.02}{}^{+0.04}$; 2408.4, $7/2^+$, $9/2^-$, $11/2^-$, < 0.03; 2670.8, $9/2^-$, $11/2^-$, $13/2^-$, < 0.03; 2727.8, $15/2^{(-)}$, $0.35_{-0.11}{}^{+0.15}$; 2741.1, $7/2^-$, $9/2^+$, $11/2^+$, $0.70_{-0.50}{}^{+0.80}$; 2786.3, $9/2^-$, $11/2^-$, < 0.04; 2810.7, $5/2^+$, $7/2^+$, $9/2^-$, < 0.06; 2860.8, $13/2^-$, $0.15_{-0.06}{}^{+0.08}$; 3017.3, $3/2^+$, $5/2^+$, $7/2^+$, < 0.06; 3133.4, $(7/2^-)$, $9/2^{(+)}$, $(11/2^-)$, < 0.06; 3133.7, $9/2^{(-)}$, $11/2^{(-)}$, $13/2^{(-)}$, $0.32_{-0.06}{}^{+0.11}$; 3259.4, undetermined, > 3, < 1000; 3341.6, $9/2^+$, $11/2^+$, $13/2^+$, > 5, < 1000. γ-ray branching ratios and multipole mixing ratios were also obtained from the data, and reduced electromagnetic transition matrix elements have been extracted for a number of observed transitions. The positive-parity states of ^{49}V were organized into two rotational bands with $K^\pi = 1/2^+$ and $K^\pi = 3/2^+$. Calculations have been performed for negative-parity states based on the strong-coupling model of Bohr and Mottelson with correctly treated phases in particle-hole excitations and the $(\Sigma_j \beta_j)^2$ term in the Hamiltonian. The results are compared with experiment. (auth)

4921 LIFETIME OF THE 3.830-MeV STATE OF ^{41}Ca. Kim, H.J.; Robinson, R.L.; Milner, W.T. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 11: No. 4, 1468-1469 (Apr 1975).

The mean lifetime of the 3.830-MeV state of ^{41}Ca was determined from the delayed coincidence measurements between neutrons and γ rays from the $^{28}Si(^{16}O, 2p n\gamma)^{41}Ca$ reaction at 40-MeV incident energy using the direct timing method. The value of 4.16 ± 0.20 nsec obtained is smaller but consistent with the "plunger" values previously reported. (auth)

4922 $(^6Li, d)$ REACTION ON fp-SHELL NUCLEI AND ALPHA-TRANSFER DISTORTED-WAVE BORN-APPROXIMATION ANALYSIS. Strohbusch, U.; Bauer, G. (Fakultät für Physik, Universität Freiburg, Freiburg, Germany); Fulbright, W.W. Phys. Rev. Lett. 34: No. 15, 968-971 (14 Apr 1975).

Strongly structured $(^6Li, d)$ angular distributions exhibiting systematic variations with A for A=40 to A=90 target nuclei are well reproduced by α-stripping calculations using a single set of potential parameters. Zero-range and finite-range distorted-wave Born-approximation results are found very similar both in the shapes of the angular distributions and in the relative magnitudes. The question of nuclear-structure dependence in the angular distributions is discussed. (auth)

4923 INDUCED QUASI-MOLECULAR K X-RAY EMISSION IN HEAVY ION COLLISIONS. Greenberg, J. S.; Davis, C. K.; Mueller, B.; Greiner, W. (Yale Univ., New Haven). pp 67-77 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The mechanisms of spontaneous and induced radiation from intermediate electronic molecules are derived from the Two Center Dirac equation in a rotating coordinate frame. Induced transitions add incoherently with spontaneous transitions to produce a characteristic directional anisotropy. An anisotropic angular distribution for high energy continuum x rays produced in $^{58}Ni + ^{58}Ni$ collisions is reported for bombarding energies of 70 and 39 MeV and detector angles of 90^0 and 15^0. The continuous spectra was investigated over an intensity range of three orders of magnitude, and it is concluded that these spectra are quasi molecular in origin. It is found that the ratio of cross sections measured at 70 and 39 MeV increases toward the high end of the spectrum as is expected if there is a contribution from induced transitions. All these observations reflect features characteristic of the formation of intermediate molecules. (7 figures) (SDF)

4924 LEVELS OF ^{56}Fe AND ^{59}Co LYING ABOVE THE NEUTRON BINDING ENERGY. Abramov, A. I.; Kitaev, V. Ya.; Yutkin, M. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2112-2118(Oct 1974). (In Russian).

The energy spectra of photoneutrons escaping from samples at an angle of 78° to the axis of a bremsstrahlung beam during the reactions $^{56}Fe(\gamma, n)$ and $^{59}Co(\gamma, n)$ near threshold were measured by the time-of-flight method. Analysis of the photoneutron yield curves showed a series of energy levels of ^{56}Fe and ^{59}Co lying above the neutron binding energy. Their energies were measured. In the neutron energy interval from 1 to 10 keV the cross sections for the (γ, n) reaction were determined from the measured photoneutron yields. The values of the resonance parameters were determined for some energy levels of Fe and Co. (6 figures, 4 tables) (tr-auth)

4925 SCATTERING OF PROTONS ON THE NUCLEUS ^{48}Ti. Antropov, A. E.; Gusev, V. P.; Zarubin, P. P.; Ioannu, P. D.; Orlov, B. N. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2167-2174(Oct 1974). (In Russian).

The angular distribution of 6.02-MeV protons elastically scattered on ^{48}Ti and the inelastic scattering cross sections up to excitation energies of 4.000 MeV were measured. The measured elastic scattering cross sections were analyzed on the basis of

the optical model with the scattering through the compound nucleus taken into account. The experimental results obtained on the angular distribution of inelastically scattered protons were processed within the framework of the McCullen-Vervier model and the Hauser-Feshbach theory. The contribution of the scattering through the compound nucleus was evaluated for all states of ^{48}Ti. The spins and parities of some highly excited levels of this nucleus were made more precise. (3 figures) (tr-auth)

4926 $d_{\frac{5}{2}}$ ANALOG RESONANCE EXCITED IN THE REACTION ^{58}Ni(p,γ)^{59}Cu. Beckert, K.; Gersch, H. U.; Herrmann, F.; Kleinwachter, P.; Schobbert, H.; Fodor, I.; Szentpetery, I. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2083-2086(Oct 1974). (In Russian).

A search was made for the isobaric analog resonance during the study of the excitation functions of the ^{58}Ni(p,γ) reaction in the energy range E_p = 4.7 to 5.2 MeV. The γ spectra of the resonances detected were measured. The spins of the resonances were identified from the asymmetry parameter I(90°)/I(0°). The angular momentum transfer was determined during measurement of the excitation function of the (p, p_0) reaction at several angles. The data indicated that the $d_{\frac{5}{2}}$ resonance was detected. (1 figure, 2 tables) (JSR)

4927 $g_{\frac{9}{2}}$ ISOBARIC ANALOG RESONANCE IN ^{53}Mn. Beckert, K.; Gersch, H. U.; Grambole, D.; Herrmann, F.; Kleinwachter, P.; Schneidereit, C.; Schobbert, H.; Thomas, H. J. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2087-2089(Oct 1974). (In Russian).

A search was made for the $g_{\frac{9}{2}}$ isobaric analog resonance in the ^{52}Cr(p,γ) ^{53}Mn reaction at proton energies of 3.9 to 4.6 MeV. The excitation functions of the reaction were measured. The resonance spectrum was characterized by a relatively intense transition of 10661 ± 3 keV to the ground state, and the asymmetry of this transition agrees with the value expected for the $^{9}/_{2}$ resonance. The de-excitation of the isobaric analog resonance occurs predominantly by an El transition to the ground state. (2 figures, 1 table) (JSR)

4928 STUDY OF EXCITED STATES OF ^{41}Sc DURING ELASTIC SCATTERING OF PROTONS BY ^{40}Ca NUCLEI. Veg, L.; Koltai, E.; Meshko, L. (Inst. of Nuclear Research, Debrecen, Hungary). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2077-2082(Oct 1974). (In Russian).

The study of the elastic scattering of protons at 1 to 5 MeV on ^{40}Ca nuclei gives data on the excited states of ^{41}Sc in the excitation energy interval from 2 to 6 MeV. The results of the analysis of the experimental data from the excitation functions of the ^{40}Ca(p,p) ^{40}Ca reaction in the framework of R-matrix theory were reported and discussed. The spins and parities of the excited levels were determined. (4 figures, 1 table) (JSR)

4929 SYSTEMATIC ERRORS IN TRANSITION INTENSITIES OF ^{56}Co AND ^{66}Ga. McCallum, G. J.; Coote, G. E. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Nucl. Instrum. Methods; 124: No. 1, 309-311(15 Feb 1975).

A systematic error in transition intensities of ^{56}Co and ^{66}Ga is reported. It is shown that above 2.5 MeV accepted values are systematically too low. (auth)

4930 PRECISE MEASUREMENT OF RELATIVE INTENSITIES OF GAMMA-RAYS FROM ^{56}Co. Katou, T. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). Nucl. Instrum. Methods; 124: No. 1, 257-263(15 Feb 1975).

The relative intensities of gamma-rays from the decay of 77.3 d ^{56}Co have been carefully determined using a high-resolution Ge(Li)-NaI(Tl) Compton suppression spectrometer. Pure cascade sources were mainly employed for the efficiency calibration. The effect of Compton back-scattering was taken into consideration for the peak area determination. The results obtained were mostly in agreement with the data published so far except for a significant discrepancy in several gamma-ray components. The discrepancy is thought to be due to the Compton back-scattering effect neglected in the previous works. (auth)

4931 QUASIMOLECULAR STATES IN THE ELASTIC α-SCATTERING ON ^{40}Ca. Friedrich, H.; Langanke, K.; Weiguny, A. (Muenster Univ. (F. R. Germany). Inst. fuer Theoretische Physik); Santo, R. (Muenster Univ. (F. R. Germany). Inst. fuer Kernphysik). Phys. Lett., B; 55: No. 4, 345-348(3 Mar 1975).

Resonance states seen in α-^{40}Ca elastic scattering are treated in a microscopic model which describes the fragments by displaced oscillator shell model functions. The minima of the energy expectation value for various angular momenta are in good agreement with the experimental resonance energies, thus confirming the concept of an underlying quasimolecular structure. (auth)

4932 INVESTIGATION OF GAMMA-RAY TRANSITIONS IN ^{56}Ni. Schneider, P.; Bodenmiller, K. H.; Buhl, S. (Heidelberg Univ. (F. R. Germany). 2. Physikalisches Inst.). Z. Phys., A.; 272: No. 1, 113-118(1975).

Angular correlation measurements for the ^{54}Fe(^{3}He,nγ)^{56}Ni reaction were performed at $E(^{3}He)$ = 12.5 MeV. Method II of Litherland and Ferguson was used to determine the multipole mixing ratio of the γ-radiation and the spins of the excited levels at 3,925 and 3,956 keV. As the most probable spin assignments we deduced 4^+ (3,925 keV) and 0^+ (1, 2) (3,956 keV). The mixing ratio found for the 1,225 keV transition from $4^+ \rightarrow 2^+$ is δ(M3/E2) = +0.21(+0.23, −0.16). This result is compared with a shell model calculation. (auth)

4933 SU(4) MODEL AND ITS APPLICATION TO THE STRUCTURE OF ENERGY LEVELS OF EXCITED Ca ISOTOPES ^{41}Ca UP TO ^{50}Ca. Schubert, D. Bonn; Univ. Bonn (1974). 107p. (In German). INIS.

Thesis.

By means of group theoretical methods a model of the interaction of particles is developed. The excited energy states of the Ca isotopes ^{41}Ca to ^{50}Ca are computed by introducing a special model Hamiltonian. This Hamiltonian consists of quadrupole and octupole forces and determines the structure of the Lie algebra, which is shown to be SU(4). (GE)

4934 LIFETIME MEASUREMENTS IN ^{56}Co. Moazed, C.; Lawson, J. C.; Dorenbusch, W. E.; Schneiders, N.; Weisman, L.; Voges, D. (Wayne State Univ., Detroit, Mich. (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 2, 242-252(24 Feb 1975).

Lifetimes of six excited states in ^{56}Co below 1.75 MeV were measured by the Doppler-shift attenuation method. The levels were excited via the ^{54}Fe(^{3}He, pγ) reaction with 10.4 MeV ^{3}He particles. Gamma rays were measured in a 45 cm^{3} Ge(Li) detector in coincidence with protons backscattered near 180°. Reduced transition probabilities extracted from measured lifetimes compare favorably with shell model predictions of McGrory. (auth)

4935 OBSERVATION OF WEAKLY COUPLED 2p-1h STATES IN ^{41}Ca FROM PROTON TRANSFER ON ^{40}K. Bohne, W.; Fuchs, H.; Grabisch, K.; Kluge, H.; Morgenstern, H. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Bereich Kern- und Strahlenphysik); Oeschler, H.; Schlegel, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Nucl. Phys., A; 240: No. 1, 171-188(10 Mar 1975).

The proton transfer on ^{40}K was studied with the ^{40}K(^{3}He,d)^{41}Ca reaction at 13 and 21 MeV bombarding energy and with the ^{40}K(d,n)^{41}Ca reaction at 6.5 MeV bombarding energy. The energy and angular distribution of outgoing particles were measured. For transitions to 62 levels in ^{41}Ca the l-values and spectroscopic factors were derived with DWBA. The excitation energies of levels populated with l = 3 and the qualitative distribution of transfer strength strongly suggest their interpretation as 2p-1h states of the $f7/2\ ^{2}d3^{-1}/2$ configuration with weak coupling between the particle pair and the hole. The high spin states of this configuration (with J^{π} up to 15+/2) are preferentially excited. (auth)

4936 SPLIT ANALOGUE OF THE 2.02 MeV STATE OF ^{47}Ca. Vingiani, G. B.; De Poli, M. (Padua Univ. (Italy). Instituto di Fisica); Alvarez, C. R.; Folkmann, F. (Niels Bohr Institutet, Copenhagen (Denmark)). Nucl. Phys., A; 239: No. 2, 221-232 (24 Feb 1975).

The elastic scattering of protons by ^{46}Ca has been measured at seven angles for E_p = 1.82-1.90 MeV. Thirteen resonances are observed and interpreted as components of the split analog of the ^{47}Ca first excited state. The resonance parameters are extracted and the proton width of the IAS is determined. The partial reduced widths are fitted to the Robson one-level formula and the pertinent parameters are deduced. In addition, γ rays from the ^{46}Ca(p,γ)^{47}Sc reaction were detected; the decay scheme and $\Gamma\gamma$ are deduced. The summed M1 strength for the IAS is 1.0W.u. Hindrance of the M1 decay is explained as resulting from the polarization due to the spin-isospin interaction, which is especially strong for the analog-to-antianalog transitions. (auth)

4937 ISOSPIN CONSERVATION AND THE INDEPENDENCE HYPOTHESIS IN THE DECAY OF ^{49}V, ^{52}Cr AND ^{55}Mn. Porile, N. T.; Lux, C. R.; Pacer, J. C.; Wiley, J. (Purdue Univ., Lafayette, Ind. (USA). Dept. of Chemistry). Nucl. Phys., A; 240: No. 1, 77-86(10 Mar 1975).

Energy spectra and angular distributions of protons and α-particles emitted in the decay of ^{49}V, ^{52}Cr, and ^{55}Mn produced by 14 MeV protons and 12 to 16 MeV A-particles were measured between 30 and 150°. The evaporation cross sections of the (p,p'), (p,α), (α,p) and (α,α') reactions were used to deduce the isospin

mixing fractions, μ, between the $T_>$ and $T_<$ states of these compound nuclei and values of 0.2 to 0.3 were obtained. The ratio of upward to downward mixing was calculated to be ~0.02. Values of the Coulomb matrix elements were deduced and found to range from ~30 to 120 eV. Measurements on the α and p exit channels permitted a test of the independence hypothesis and the latter was verified for ^{49}V and ^{53}Mn. (auth)

4938 keV NEUTRON RADIATIVE CAPTURE AND TOTAL CROSS SECTION OF ^{50,52,53}Cr, ^{54,57}Fe, AND ^{62,64}Ni. Beer, H.; Spencer, R. R. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kernphysik). Nucl. Phys., A; 240: No. 1, 29-53(10 Mar 1975).

Enriched samples of ^{50,52,53}Cr, ^{54,57}Fe and ^{62,64}Ni were measured in capture and, with the exception of ^{52}Cr and ^{57}Fe, in transmission in the energy ranges 5 to 200 keV and 10 to 300 keV, respectively. The capture and total cross section data analyzed provided resonance parameters for both s-wave and l > 0 wave resonances. The s- and p-wave strength functions were determined and neutron width and level spacing distributions established. A positive correlation was found between the radiation widths and the reduced neutron widths. (auth)

4939 SEARCH FOR ANALOGUE RESONANCES IN ^{57}Co. I. El-Kateb, S.; Griffiths, G. M. (British Columbia Univ., Vancouver (Canada). Dept. of Physics). Nucl. Phys., A; 240: No. 1, 120-136 (10 Mar 1975).

The excitation function for the reaction ^{56}Fe(p,γ)^{57}Co has been measured in the energy region E_p = 1200-3000 keV. The E_p = 1248, 1262 and 1267 keV resonances have been studied. The J^π values have been determined as $^3/_2^-$ for these resonances, which are believed to form the split analog of the 14-keV state in ^{57}Fe. Gamma branching ratios and resonance strengths of all above mentioned resonances have been studied. The M1 transition strengths to the corresponding antianalog states have been measured and compared with theoretical predictions. The reaction Q-value and the Coulomb displacement energy are given. The absence of the isobaric analog resonance corresponding to the ground state in ^{57}Fe is discussed as a result of the present study. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 4578, 4846, 4907, 4914, 4922, 4924, 4926, 4929, 4938, 4986, 4997, 4998, 5022, 5039, 5140, 5160, 5201, and 5206.

4940 (BNL-19788) GAMMA-RAY SPECTRA FROM 1 EQUALS 1 NEUTRON CAPTURE NEAR 24 keV. Rimawi, K.; Chrien, R. E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 3p. (CONF-750303-58). Dep. NTIS $4.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

The characteristics of neutron capture gamma-ray spectra near E/sub n/ equals 24.3 keV are discussed. The E-1 transitions following the capture of p-wave neutrons show a marked preference for populating low-lying states with an s or d single-particle character. This preference introduces a significant correlation between partial (n,gamma) cross sections and the neutron reduced widths for final states as measured in the (d,p) reaction. (auth)

4941 (CEA-N-1700, pp 35-41) STUDY OF ONE- AND TWO-PROTON-TRANSFER REACTIONS INDUCED BY ^{12}C AND ^{16}O BEAMS. Cunsolo, A. (Univ., Catania, Italy); Lemaire, M. C.; Mermaz, M. C.; Sztark, H. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

A comparison of the ^{64}Ni(^{12}C,^{11}B)^{65}Cu and ^{64}Ni(^{16}O,^{15}N)^{65}Cu one-proton transfer reactions has been performed. It establishes that these reactions are very selective with respect to the configuration populated in the residual nucleus. Angular distributions of the (^{12}C,^{10}Be) and (^{16}O,^{14}C) reactions have also been measured. Compared to the one-proton transfer data, they exhibit a strong shift to forward angles. The DWBA analysis of these data is discussed. (auth)

4942 (CEA-N-1700, pp 54-60) STUDIES OF ELECTROMAGNETIC TRANSITIONS AND LIFETIME MEASUREMENTS FOR NICKEL ISOTOPES. Ballini, R.; Beuzit, P.; Delaunay, J.; Fodor, I.; Fouan, J. P.; Ronsin, H.; Cindro, N.; Delaunay, B.; Pichevar, M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

The scheme of ^{60}Ni was investigated up to 5.9 MeV. The Doppler shift attenuation technique was used to investigate the lifetimes of 33 states of ^{60}Ni up to 5.6 MeV of excitation; 18 were measured for the first time. Gamma rays from the ^{60}Ni(p,p'γ) reaction were observed in coincidence with protons by two Ge(Li) detectors at 40° and 130° lab. We find a new doublet (3.381-3.393 MeV) and give several previously unknown γ-ray branching ratios; the lifetimes allow one to attribute some spins or parities or to reject other assignments. (auth)

4943 (CEA-N-1700, pp 122-123) STUDY OF THE $T_>$ STATES OBTAINED BY THE REACTIONS ^{60,62,64}Ni(^{3}He,d)^{61,63,65}Cu. Ashery, D. (Tel Aviv Univ., Israel); Boudard, A.; Bruge, G.; Chaumeaux, A.; Finkle, G.; Yavin, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

The study of the unbound $T_>$ states through the (^{3}He,d) reaction has been extended to the ^{60,61,62,64}Ni targets. (auth)

4944 (CEA-N-1700, pp 124-125) (α,α') SCATTERING ON ^{60,64}Ni AT 29.6 MeV. Boudard, A.; Bruge, G.; Chaumeaux, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

Preliminary data for the study of the inelastic scattering of 29.6 MeV alpha-particles on ^{60}Ni and ^{64}Ni have been taken using solid state counters. States up to 7.1 MeV in ^{60}Ni and 6.1 MeV in ^{64}Ni have been identified. (auth)

4945 (RLO-1388-258, pp 142-145) ^{89}Y(p,γ)^{90}Zr REACTION ABOVE THE GIANT-DIPOLE RESONANCE. Brown, D. R.; Ebisawa, K.; Snover, K. A. Jun 1974.

In annual report, 1974.

4946 *s*- AND *p*-WAVE NEUTRON SPECTROSCOPY. Xc. INTERMEDIATE STRUCTURE: ^{88}Sr. Malan, J.G.; Pineo, W.F.E.; Divadeenam, M.; Choi, B.H.; Bilpuch, E.G.; Newson, H.W. (Duke University and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27706). Ann. Phys. (N.Y.) 89: No. 2, 284-298 (Feb 1975).

Neutron total cross section measurements of natural Sr were made from 50-875 keV using a high-resolution proton beam and the ^{7}Li(*p*,*n*) reaction as a neutron source. These data were analyzed with the help of an *R*-Matrix code to extract resonance (energies and other) parameters up to about 850 keV. 2p-1h and particle-vibration doorway interpretation of the *s*-,*p*- and *d*-wave resonances is attempted in terms of the sum rule $\Sigma\gamma_n^2=\gamma_d^2$. Predictions based on both of these models agree with the experimental results. As expected the *p*-wave resonances are stronger than either *s*- and *d*-wave structure. Theory accounts for the *p*-wave strength remarkably well. Possible location of the *p*-wave s.p. resonance is reproduced with a real potential, and its damping due to the imaginary potential is calculated. More fragmentation of the strong *p*-wave doorways is observed than was expected for a compound nucleus so near ^{90}Zr, but a larger strength function is observed, apparently due to the *p*-wave giant resonance. (auth)

4947 ^{78,80,82}Kr(*d*, *p*)^{79,81,83}Kr REACTIONS. Chao, J.; Olsen, D.K.; Newsom, C.; Riley, P.J. (Center for Nuclear Studies, The University of Texas, Austin, Texas 78712). Phys. Rev. C 11: No. 4, 1237-1246 (Apr 1975).

The level structures of ^{79,81,83}Kr have been investigated via the (*d*, *p*) stripping reaction using isotopically enriched gas targets at an incident deuteron energy of 11 MeV. Proton groups leading to about 14 states with excitation energies up to approximately 3 MeV have been identified in each of the above nuclei. Differential cross sections were measured from 20° to 160°, and were fitted with zero-range distorted-wave-Born-approximation calculations. Excitation energies, *l* values, spectroscopic factors, and the implied values of J^π are given. Comparisons are made with states in the selenium and germanium isotopes having the same number of neutrons and, respectively, one and two protons less than the krypton isotopes. Comparisons are also made between the present work and studies of ^{79}Kr via ^{79}Rb decay measurements. Two unresolved discrepancies are found between the two sets of measurements. (auth)

4948 ^{87}Sr(*d*, ^{3}He)^{86}Rb REACTION AND CONFIGURATION MIXING IN ^{86}Rb. Duray, J.R.; Noble, M. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540); Comfort, J.R.; Braithwaite, W.J. Phys. Rev. C 11: No. 4, 1292-1297 (Apr 1975).

The ^{87}Sr(*d*, ^{3}He)^{86}Rb reaction was studied at a bombarding energy of 28 MeV. All known low-lying negative-parity states were observed; positive-parity states were either weak or absent. A new negative-parity state is suggested near 1.03 MeV. Distorted-wave calculations were made in order to extract spectroscopic factors. Much mixing of $l = 1$ and $l = 3$ transfers is observed. Detailed comparisons are made with wave functions proposed by Kolata *et al.* Somewhat larger configuration mixing is found, in keeping with known effects of $g_{9/2}$ neutron holes on $p_{1/2}$ and $f_{5/2}$ protons. (auth)

4949 MASSES OF ^{74}Br AND ^{76}Br. Lueders, D.H.; Daley, J.M.; Buccino, S.G.; Durham, F.E. (Tulane University, New Orleans, Louisiana 70118); Hollandsworth, C.E.; Bucher, W.P.; Jones, H.D. Phys. Rev. C 11: No. 4, 1470-1472 (Apr 1975).

Threshold energies for the $^{74}Se(p, n)^{74}Br$ and $^{76}Se(p, n)^{76}Br$ reactions were obtained from excitation functions of low-lying excited levels in $^{74,76}Br$ and the first excited level in ^{74}Se. The ground state threshold results of 7.805 ± 0.015 and 5.815 ± 0.015 MeV, respectively, yield mass excesses of −65.302 ± 0.015 MeV for ^{74}Br and −70.303 ± 0.015 MeV for ^{76}Br. Results are compared to published values, which are in error by 100–180 keV. (auth)

4950 THERMAL NEUTRON CAPTURE GAMMA RAYS FROM NEUTRON CAPTURE IN ^{59}Ni AND ^{63}Ni. Wilson, W.M.; Thomas, G.E.; Jackson, H.E. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 11: No. 4, 1477-1481 (Apr 1975).

The thermal neutron capture γ-ray spectra for ^{60}Ni and ^{64}Ni have been observed from a sample previously irradiated to produce long-lived isotopes of ^{59}Ni and ^{63}Ni. New values of the neutron binding energy have been obtained for the compound systems ^{59}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, and ^{64}Ni. The γ-ray spectra for neutron capture by ^{59}Ni and ^{63}Ni are not so strongly peaked at high energies as the γ-ray spectra observed for neutron capture by the even-mass target nuclei in the A ≃ 40−60 mass region. (auth)

4951 PROTON-NUCLEUS INTERACTIONS AT HIGH ENERGIES AND SCALING. Jain, P.L.; Girard, B.; Kazuno, M.; Thomas, G. (High Energy Experimental Laboratory, Department of Physics, State University of New York at Buffalo, Buffalo, New York 14214). Phys. Rev. Lett. 34: No. 15, 972-974 (14 Apr 1975).

In proton-nucleus interactions at 200 GeV in nuclear emulsion we have found that in the projectile region the multiplicity is independent of the target nucleus, while in the target region it is approximately proportional to the nuclear thickness. After carefully excluding the elastic and the coherent events, we find that the secondary particles produced in *p*-nucleus collisions obey the same Koba-Nielsen-Olesen scaling as found previously in *p-p* collisions. (auth)

4952 ROLE OF COULOMB AND NUCLEAR INTERACTIONS IN SHAPING THE TOTAL DEUTERON REACTION CROSS SECTION. Dubar, L. V.; Nemets, O. F.; Slyusarenko, L. I.; Tokarevskii, V. V. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2186-2190(Oct 1974). (In Russian).

Theoretical values of the total reaction cross section were calculated for target nuclei from Be to U for deuteron energies of 13.6 and 22.4 MeV. The calculations were made with averaged parameters of the optical potential. It was shown that the reaction cross section changes irregularly in the regions 56 < A < 65 and 100 < A < 160 at 13.6 MeV and in the region 100 < A < 180 at 22.4 MeV. Competition between the Coulomb and nuclear interactions plays a substantial role in the irregularities observed in the behavior of the cross section in the region 56 < A < 65 at low deuteron energies. An analysis was made of the total deuteron reaction cross section for isotopes of Cr, Fe, Ni, and Zn and for isotopes with N = 26, 28, 30, and 36. (3 figures, 1 table) (tr-auth)

4953 HIGHER-ORDER TERMS IN l-FORBIDDEN β TRANSITIONS. Batkin, I. S.; Berkman, M. I.; Kopytin, I. V. (Voronezh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2222-2227(Oct 1974). (In Russian).

The l-forbidden β transitions between the ground states of nuclei in the 2p−1f shell were studied. With consideration of the higher-order terms for ^{65}Ni, ^{65}Zn, ^{65}Ga, ^{67}Cu, and ^{69}Ge, the following characteristics were calculated: spectrum shape, reduced lifetime, and longitudinal polarization of β particles. The calculations were compared with available experimental data. (1 figure, 2 tables) (JSR)

4954 AN INVESTIGATION OF ^{73}As ENERGY LEVELS BY MEANS OF (p,n) AND (p,nγ) REACTIONS. Van der Merwe, P.; Barnard, E.; De Villiers, J. A. M.; Malan, J. G. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nucl. Phys., A; 240: No. 2, 273-292(17 Mar 1975).

The energy levels of ^{73}As were studied by means of the $^{73}Ge(p,n)^{73}As$ reaction at proton energies between 2.1 and 3.3 MeV. Neutron energies were measured by time of flight, and γ-ray energies, with Ge(Li) detectors. The γ decay of levels was studied by means of γ−n coincidences. Angular distributions were measured for the strongest de-excitation γ-rays, and relative excitation strengths of levels were derived from the neutron spectra. These are compared with predictions of the statistical theory to derive spins for a number of levels. A level and decay scheme for ^{73}As up to 1.98 MeV excitation is presented. (auth)

4955 NUCLEAR RESONANCE FLUORESCENCE STUDIES WITH ^{65}Cu. Kollewe, D. Marburg, Ger.; Univ. Marburg (1972). 43p. (In German). INIS.

Thesis.

In the present work, a new method is shown to determine the lifetime and simultaneously measured particles of the microspectrum by means of nuclear resonance fluorescence. (GE)

4956 DIFFRACTION COHERENT PARTICLE PRODUCTION BY 200 GeV/c PROTONS ON EMULSION NUCLEI. Azimov, S. A.; Gulamov, K. G.; Riskiev, T. T.; Svechnikova, L. N.; Chernova, L. P.; Chernov, G. M. (AN Uzbekskoi SSR, Tashkent, Fiziko-Tekhnicheskii Inst.). Dokl. Akad. Nauk SSSR; 218: No. 4, 807-809(1 Oct 1974). (In Russian).

Measurements were carried out on the cross-sections of reactions involving 1, 3, 5 and 7 charged particles in the final state for inelastic, coherent interactions of 200-GeV/c protons with photoemulsion nuclei. Estimates were also obtained on the cross-sections of the dissociation reactions $p \rightarrow p\,\pi^+\pi^-$ and $p \rightarrow p\,2\pi^+\,2\pi^-$, and on the distribution of the effective masses of the particles in these reactions. The energy dependencies of the cross section and of the distribution $d\sigma/dM^2$ for the $p \rightarrow p\pi^+\pi^-$ reaction agree with calculations according to the model of single-pion exchange with a nucleus. The shapes of the mass spectrum are qualitatively similar on taking into account the smaller absolute values of the mass M in the nuclear collisions. This behavior indicates a single mechanism of particle generation. (tr-auth)

4957 COULOMB EXCITATION OF ^{67}Zn AND CORE-QUASIPARTICLE COUPLING IN $f_{\frac{5}{2}}$ NUCLEI. Throop, M. J.; Cheng, Y. T.; McDaniels, D. K. (Oregon Univ., Eugene (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 2, 333-352(24 Feb 1975).

A qualitative explanation of the low lying levels of $g_{\frac{9}{2}}$ shell nuclei using a recent theoretical improvement upon quasiparticle-phonon coupling theories has motivated the investigation of ^{67}Zn, which belongs in the $f_{\frac{5}{2}}$ neutron shell. A Coulomb excitation experiment was performed with 3.2 to 4.86 MeV α-particles. De-excitation γ-rays were observed with a 45 cm^3 Ge(Li) detector. In addition to excitation of previously known states at 184.6 keV ($\frac{3}{2}^-$) and 880.0 keV ($\frac{5}{2}^-$), strong excitation of states at 815.2 keV ($\frac{5}{2}^-$, $\frac{7}{2}^-$) and 870.9 keV ($\frac{3}{2}^-$, $\frac{5}{2}^-$, $\frac{7}{2}^-$) was observed. The latter state also appears to have been observed in high resolution (d,p) stripping work. Angular distribution data were taken at E_α = 4.0 and 4.86 MeV, and were used to obtain branching ratios, reduced upward transition probabilities, mixing ratios and spin assignments. The B(E2)↑ associated with the ^{67}Zn levels populated in this experiment are (in units of $e^2 \cdot b^2$) 184.6 keV (0.0190 ± 0.0014), 393.6 keV (0.00049 ± 0.00003), 815.2 keV (0.029 ± 0.002), 870.9 keV (0.04 ± 0.02), and 888.0 keV (0.0086 ± 0.0006). An extensive diagonalization using three single-quasiparticle states ($f_{\frac{5}{2}}$, $p_{\frac{3}{2}}$, and $p_{\frac{1}{2}}$) in ^{67}Zn, each coupled to a core phonon, was carried out and detailed predictions were made for level energies, reduced transition probabilities, magnetic dipole electric quadrupole moments, relative γ-ray intensities, and mixing ratios. Generally, the predictions are in good agreement with ^{67}Zn experimental data. Data for other $f_{\frac{5}{2}}$ shell nuclei lend further qualitative support to a quasiparticle-phonon coupling picture for odd-A nuclei in the $f_{\frac{5}{2}}$ shell. It is suggested that an extra $\frac{3}{2}^-$ low-lying level present in several $f_{\frac{5}{2}}$ shell nuclei has characteristics similar to those of the three-quasiparticle "intruder" state described by Kisslinger. (auth)

4958 LEVEL STRUCTURE OF ^{76}As. Lemming, J. F.; Rapaport, J. (Ohio Univ., Athens (USA)); Elwyn, A. J. (Argonne National Lab., Ill. (USA)). Nucl. Phys., A; 239: No. 3, 412-426 (3 Mar 1975).

The energy-level structure of ^{76}As has been studied by the $^{75}As(d,p)$ reaction with 12.0 MeV incident deuterons. Eighty-seven excited energy levels up to 2.5 MeV have been identified. The angular distributions for thirty-nine of the observed transitions are compared with distorted-wave Born approximation calculations. Angular momentum transfers are determined and spectroscopic strengths are deduced from the data. The results are compared with shell-model sum rules and with (d,p) results on N = 42 isotones. Possible spin values are assigned for some of the levels based on the present results, (n,γ), (p,n) and (p,nγ) studies. (auth)

4959 (γ,p) CROSS SECTIONS AND ISOSPIN SPLITTING OF THE GIANT DIPOLE RESONANCE IN N = 50 NUCLEI. Shoda, K.; Miyase, H.; Sugawara, M.; Saito, T.; Oikawa, S.; Suzuki, A.; Uegaki, J. (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science). Nucl. Phys., A; 239: No. 3, 397-411(3 Mar 1975).

The differential (e,e'p) cross sections of ^{88}Sr, ^{89}Y, ^{90}Zr and ^{92}Mo have been measured at $\theta = 90°$. The results are used to obtain the (γ,p) cross sections by correcting with the angular distribution data. The (γ,p) cross sections are compared with the (γ,n) cross sections. A resonance corresponding to the $T_<$ GDR is found, and another resonance is separated by fitting a Lorentz line with a width equal to that of the (γ,n) GDR. The ratios $\sigma(\gamma,p)/\sigma(\gamma,n)$ and $\sigma(\gamma,p_0)/\sigma(\gamma,p)$ show differences between the two resonances. The two GDR resonances are studied from the isospin splitting point of view. The sum rule and splitting energy of the (γ,p) GDR agree well with theory. However, when

the sum of the (γ,p) and (γ,n) experimental data is taken, the results are too large to be explained by the $T_>$ GDR. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 4578, 4773, 4775, 4777, 4907, 4923, 4940, 4945, 4952, 4956, 4959, 4986, 5014, 5027, 5028, 5039, 5052, 5053, 5081, 5115, 5121, 5128, 5129, 5140, 5142, 5143, 5148, 5151, 5160, 5184, 5185, 5192, and 5222.

4960 (ANU-P-607) ANNUAL REPORT, 1974. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Jan 1975. 47p. Dep. NTIS (US Sales Only) $5.50.

The operation of the 14 UD tandem accelerator and other research equipment is outlined. Research programs are proceeding in the following topics: direct reactions, heavy ion reactions, spectroscopy of light nuclei, radiative capture of alpha particles, neutron capture of gamma rays, Coulomb excitation, heavy-ion xn reactions, and ion-solid interaction. (auth)

4961 (CEA-N-1700) PROGRESS REPORT OF THE NUCLEAR PHYSICS DEPARTMENT, 1 OCTOBER 1972 – 30 SEPTEMBER 1973. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Dept. de Physique Nucleaire). 1973. 303p. (In French). Dep. NTIS (US Sales Only) $18.25.

Summaries of the researches and the technological studies carried out at the Nuclear Physics Department of Saclay during the past year are presented. These studies concern the nuclear structure and reaction mechanisms and they have been performed on the tandem accelerator of 8.5 MeV, the variable energy cyclotron of 30 MeV, the 60 and 600 MeV electron linear accelerators and on the high resolution spectrometer for 1 GeV protons at the Saturne synchrotron. Individual abstracts were prepared for 53 summaries. (auth)

For abstracts of individual sections see: 3570–3577, 3615, 4609, 4765, 4766, 4785–4788, 4810–4820, 4874–4876, 4905–4907, 4941–4944, 4962–4967, 5007–5009, 5037, 5058–5061, and 5098.

4962 (CEA-N-1700, pp 42-45) STUDY OF THE SELECTIVITY OBSERVED IN THE REACTION $^{90}Zr(^{16}O,^{12}C)^{94}Mo$. Bonche, P. (CEN, Saclay, France); Cassagnou, Y.; Faraggi, H.; Jaffrin, A.; Legrain, R.; Morrison, G.; Papineau, A. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

Starting from a shell model description of ^{94}Mo levels, cross sections of the $^{90}Zr(^{16}O,^{12}C)^{94}Mo$ reaction were calculated for 110 final states using the SETILL code in order to reproduce and explain the selective excitation of a few number of levels which is observed on energy spectra. (auth)

4963 (CEA-N-1700, pp 46-48) STUDY OF THE REACTIONS INDUCED BY 64 MeV ^{16}O PROJECTILES ON ^{116}Sn AND ^{124}Sn TARGETS. Conjeaud, M.; Harar, S.; Lepine, A.; Da Silveira, E.; Volant, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

Elastic and inelastic scattering data have been obtained and analyzed using the Magali and ECIS 70 codes of Raynal. One-proton transfer shows to proceed mainly by a one-step direct reaction. Two, three and four-nucleon transfer spectra show maximum of cross sections at certain Q values. Data have been analyzed in the framework of classical description using Coulomb trajectories for entrance and outgoing channels. (auth)

4964 (CEA-N-1700, pp 62-63) SPECTROSCOPY STUDY OF ^{142}Pr BY MEANS OF ANALOG STATES. Cassagnous, Y.; Lamehi-Rachti, M.; Levi, C.; Mittig, W.; Papineau, L. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

Analogue states in ^{142}Nd have been studied through elastic and inelastic proton scattering on ^{141}Pr in the energy range E_p = 9, 10 MeV. Some preliminary calculations have been done with the wave functions provided by the analysis of the $^{141}Pr(d,p)^{142}Nd$ reaction. (auth)

4965 (CEA-N-1700, pp 101-103) INELASTIC SCATTERING OF 24.5 MeV PROTONS ON THE N = 82 ISOTONES (^{138}Ba, ^{140}Ce, ^{142}Nd, AND ^{144}Sm). Boudard, A.; Bruge, G.; Chaumeaux, A.; Escudie, J. L.; Terrien, Y. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

Differential cross sections of proton inelastic scattering to several collective levels of N = 82 isotones have been measured at 24.5 MeV incident energy. The analysis is reported. (auth)

4966 (CEA-N-1700, pp 201-202) SAMARIUM MUONIC ATOMS. Barreau, P.; Powers, R.; Roussel, L. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

Muonic x-rays of the sequence ^{148}Sm, ^{150}Sm, ^{152}Sm, ^{154}Sm were measured. The data will allow to reach for each isotope the half density radius, the skin thickness, the intrinsic quadrupole moment and information concerning the nuclear polarizability of the nucleus. (auth)

4967 (CEA-N-1700, pp 232-235) INVESTIGATION OF THE GIANT RESONANCE OF Mo AND Sm ISOTOPES. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972 – 30 September 1973.

The change in the form of the giant dipole resonance (GDR) for nuclei with A ≥ 100 was investigated in the case of Mo and Sm isotopes. The dynamical collective model allows the GDR width to be predicted as a function of the nuclear deformation. The photoneutron cross sections were measured for ^{92}Mo, ^{94}Mo, ^{98}Mo, ^{100}Mo, and ^{144}Sm, ^{148}Sm, ^{150}Sm, ^{152}Sm, ^{154}Sm. A representation using Lorentz lines is given. The GDR splitting observed for ^{152}Sm and ^{154}Sm is specific for stretched deformed nuclei. (FR)

4968 (JINR-D3-7991, pp 91-95) BREAKDOWN OF THREE-DIMENSIONAL PARITY IN THE REACTION $^{113}Cd(n,\gamma)^{114}Cd$. Abov, Yu. G. (Inst. of Theoretical and Experimental Physics, Moscow). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The breakdown of three-dimensional parity in the $^{113}Cd(n,\gamma)^{114}Cd$ reaction is shown either in the form of asymmetry of the angular distribution of γ quanta during the capture of polarized thermal neutrons or in the form of circular polarization of γ quanta during capture of nonpolarized neutrons. The experimental results obtained at ITEF on the asymmetry of the flight of γ quanta are reported, analyzed, and compared with the results obtained by Danish and American investigators. It is concluded that the totality of results confirms that the existence of weak nucleon–nucleon interactions is proven. (1 table) (JSR)

4969 (JINR-D3-7991, pp 294-314) γ-DECAY OF NEUTRON RESONANCES. Bechvarzh, F. (Joint Inst. for Nuclear Research, Dubna, USSR). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

Data obtained in recent years on the properties of the primary γ radiation from neutron resonances clearly indicate that the statistical model does not give an accurate description. Experimental results obtained on the fluctuation of the partial radiation widths, showing the inadequacies of the statistical model, are discussed. Other properties of resonance decay which are not directly attributed to specific models of capture mechanisms are discussed individually on the basis of literature data. (6 figures) (JSR)

4970 (JINR-D3-7991, pp 358-402) SELECTED TOPICS IN NUCLEAR-STRUCTURE INVESTIGATIONS WITH FAST NEUTRONS. Cindro, N. (Inst. Rudjer Boskovic, Zagreb). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

This survey is dedicated to nuclear-spectroscopy investigations other than slow-neutron-capture resonance phenomena. It enumerates fields where open problems make active investigation possible and hold promise. The following fields are discussed: properties of states in the continuum near the particle-emission threshold; cluster structure of light nuclei; population of single-particle states in nuclei by the (n,α) reaction; structure effects in (n,2n) reactions (the Csikai–Petö effect and shell-structure effects, the decay of states near the neutron-emission threshold); and the (n,γ) cross sections at 14 MeV. (15 figures, 4 tables) (RWR)

4971 (JINR-D3-7991, pp 403-419) NUCLEAR PSEUDOMAGNETISM. Glaettli, H. (CEN, Saclay, France). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The concept of the pseudomagnetic moment and of the pseudomagnetic field is introduced in connection with thermal neutron scattering by nuclei. An experiment is described which demonstrated the physical reality of this pseudomagnetic field in a twofold way. The shift of the Larmor frequency of the neutrons in the presence of a static pseudomagnetic field was measured by resonant reorientation of the neutron polarization. This resonance was itself introduced by a component of the pseudo-

magnetic field rotating at the neutron Larmor frequency. An apparatus is described based on the split-coil method of Ramsey which is used to measure systematically pseudomagnetic moments μ^* and thus spin-dependent scattering lengths. Results of μ^* are given for the nuclei ^{7}Li, ^{27}Al, ^{45}Sc, ^{91}Zr, ^{93}Nb, ^{139}La, and ^{181}Ta. (5 figures, 1 table) (auth)

4972 (JINR-D3-7991, pp 420-422) SEVERAL POSSIBLE EXPERIMENTS WITH SLOW NEUTRONS. Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II internatiocnal school on neutron physics.

Two experiments are proposed for detecting the existence of a pseudomagnetic field. The first is similar to that described by H. Glaettli [preceding paper], but it is proposed that the target consist not of protons but of polarized nuclei with spin $j \geq 1$. The second experiment is based on the measurement of the intensity of the beam of scattered neutrons. (JSR)

4973 (LNF-74/62(R)) NUCLEAR SCATTERING OF MONOCHROMATIC AND PLANE-POLARIZED GAMMA RAYS. Proposed Experiments. Fubini, A.; Marino, A.; Matone, G.; Prosperi, D.; Roccella, M.; Schaerf, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 29 Nov 1974. 15p. Dep. NTIS (US Sales Only) $4.00.

A proposal for an experiment to study the de-excitation properties of the electric dipole and quadrupole nuclear giant resonances is presented. Systematic cross section measurements were to be carried out for nuclear elastic and inelastic scattering of monochromatic and plane-polarized gamma rays. (JFP)

4974 (ORNL-TM-4872) COUPLED 100-GROUP NEUTRON AND 21-GROUP GAMMA-RAY CROSS SECTIONS FOR EPR CALCULATIONS. Plaster, D. M.; Santoro, R. T.; Ford, W. E. III. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 15p. Dep. NTIS $4.00.

Coupled 100-group neutron and 21-group gamma-ray 800^{0}K cross sections have been generated using the latest ENDF/B cross section data for H, He, ^{6}Li, ^{7}Li, Be, ^{10}B, ^{11}B, C, O, F, Al, Tl, V, Cr, ^{55}Mn, Fe, ^{59}Co, Ni, Cu, Nb, and Pb. The procedures used to generate these cross sections and the organization of the cross-section tape in ANISN format are discussed. (3 tables, 2 figures) (auth)

4975 (ORNL-TM-4885, p 12) NEUTRON SEPARATION ENERGIES OF TIN ISOTOPES. Slaughter, G. G.; Raman, S. Apr 1975.

In report to the U. S. Nuclear Data Committee.

4976 (WANL-TME-2744) CASCADE-CASING: COMPUTER CODES FOR CALCULATING GAMMA-RAY PRODUCTION CROSS SECTIONS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1970. 177p. Dep. NTIS $12.00.

The equations derived by E. S. Troubetzkoy for predicting gamma-ray cascade spectra following nuclear reactions are coded in CASCADE. Inelastic neutron scattering and radiative neutron capture are the nuclear reactions considered as causing the initial excitation of the nucleii. One of the quantities required in the CASCADE calculation is the maximum excitation energy, ϵ, of the residual nucleus. There are three methods of obtaining ϵ depending on whether one inputs 1) a series of values of ϵ, 2) a series of values of single neutron energies, or 3) neutron energy group boundaries. For the first option only the CASCADE calculation is performed; for the second two options there is a subsequent CASING calculation. For each value of ϵ CASCADE calculates a gamma-ray spectrum including discrete lines and a continuous portion. This information is printed out, and may also be plotted. For options 2 and 3, the information is also stored on a tape. Results for many isotopes may be stored on the same tape. Using the information on the tape as well as a gamma ray energy group structure for input, the computer program CASING provides the group cross sections in the form of two basic matrices. The ij element of one matrix gives the average number of photons produced in group j for each reaction induced by a neutron whose energy lies in group i (option 3) or each neutron of energy E_i (option 2); the ij element of the second matrix gives the average radiant energy emitted in group j for each reaction induced by a neutron whose energy lies in group i. These matrices are a necessary ingredient of shielding and heating calculations; the punch-out format of these quantities is variable. In addition to the basic matrices, there is an option in CASING for calculating a partial cross section for producing a single gamma ray in each of the various gamma-ray groups. The cross section for the neutron-nucleus reaction must be input for each neutron group before this matrix can be generated. The generation of a corresponding partial cross section for the creation of radiant energy is also optional. Since the computer time required for a CASING calculation is short (about 10 to 20 sec.) relative to a CASCADE calculation, there is little expense involved in rerunning CASING if a different gamma-ray energy group structure is desired. An option has been provided in CASING for collapsing the neutron group structure provided the broad-group boundaries coincide with the fine group boundaries. If a finer neutron group structure is desired, then a new CASCADE tape should be generated. CASCADE and CASING are FORTRAN IV codes that have been programmed for operation on a CDC-6600 computer. (auth)

4977 NEUTRON FLUX MEASUREMENT IN THE keV ENERGY REGION: SUITABILITY OF INDIUM AS AN ACTIVATION STANDARD FOR keV NEUTRONS. Ryves, T. B. (National Physical Lab., Teddington, Eng.). pp 255-257 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

For measuring monoenergetic neutron fluxes in the energy range 100-1000 keV by activation of small discs, the accepted standard material, gold, can be unsuitable because of inconveniently long half-life and insufficient intensity of the induced activity. The suitability of indium as an activation standard for keV neutrons and the required improved knowledge of the ^{115}In capture cross section are discussed. (auth)

4978 NEW EMITTERS OF DELAYED PROTONS ^{116}Cs, ^{119}Ba, ^{121}Ba. Bogdanov, D. D.; Dem'yanov, A. V.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 233-238(Feb 1975). (In Russian).

Delayed-proton emitters ^{116}Cs, ^{119}Ba, and ^{121}Ba are identified in the heavy-ion beam by means of the mass separator BEMS-2. These isotopes were obtained by exposing the targets of natural zirconium and ^{92}Mo to the beam of ^{32}S ions. The isotope ^{116}Cs has a half-life $T_{\frac{1}{2}} = (3.9 \pm 0.4)$ sec., the delayed-proton spectrum is in the interval from 2.0 up to 6.5 MeV. The half-life periods for the isotopes ^{119}Ba and ^{121}Ba are (5.35 ± 0.30) sec. and (29.7 ± 1.5) sec., and the proton spectra are in the intervals 2.0 to 6.0 and 2.0 to 4.0 MeV, respectively. The branchings p/β^+ are measured for ^{116}Cs, ^{121}Ba; the results are $\sim 3 \cdot 10^{-3}$ and $\sim 2 \cdot 10^{-4}$, respectively. (auth)

4979 TECHNIQUES IN POLARIZATION PHYSICS. Clausnitzer, G. (Univ., Giessen, Ger.). pp 1-37 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

A review of the current status of the technical tools necessary to perform different kinds of polarization experiments is presented, and the absolute and relative accuracy with which data can be obtained is discussed. A description of polarized targets and sources of polarized fast neutrons is included. Applications of polarization techniques to other fields is mentioned briefly. (SDF)

4980 INTERNAL COMPTON EFFECT IN ^{113}In. Jurčević, M.; Ilakovac, K.; Krečak, Z. (Institute Rudjer Bošković, Zagreb, Yugoslavia). Phys. Rev. C 11: No. 4, 1312-1322 (Apr 1975).

Previous measurements of the $e\gamma$ double decay of ^{113}In at 35° have been extended to relative angles of emission of 15, 30, 45, 60, 90, 120, and 150°. The energy distributions of photons have been determined at each angle in the range from 30 to 210 keV and from 35 to 197 keV for $K\gamma$ and $(L + M + N)\ \gamma$ decays, respectively. The data are in agreement with the theory of the internal Compton effect of Spruch and Goertzel and the theory of radiation losses in internal conversion of Baumann and Robl. The maximum of the transition probability has been found at (39.8 ± 2.2) °, while that predicted by the theories is at 34.6°. The calculations have also been performed using the theory of "nuclear" $e\gamma$ double decay of Grechukhin. It has been shown that the contributions of this mechanism to the observed results are negligible. The integral coefficients obtained are $B_{K\gamma} = (1.11 \pm 0.04) \times 10^{-3}$ for photons in the energy range from 35 to 105 keV and $B_{(L+M+N)\gamma} = (1.01 \pm 0.08) \times 10^{-3}$ for photons in the energy range from 42 to 105 keV. (auth)

4981 RADIOACTIVE DECAY OF 30-h ^{131}Te^m AND 25-min ^{131}Te^g TO LEVELS OF ^{131}I. Jackson, S.V.; Walters, W.B. (Department of Chemistry, University of Maryland, College Park, Maryland 20742); Meyer, R.A. Phys. Rev. C 11: No. 4, 1323-1352 (Apr 1975).

High-resolution Ge(Li) detectors have been used to observe γ-ray singles and coincidence spectra of 30-h $11/2^-$ ^{131}Te^m and of 25-min $3/2^+$ ^{131}Te^g. Sources were produced by neutron irradiation of enriched ^{130}Te metal, and, in the case of ^{131}Te^m, were chemically purified to remove the ^{131}I daughter. A total of 190 and 80 γ rays are attributed to the decays of ^{131}Te^m and ^{131}Te^g, respectively; and 174 and 77 of these transitions have been placed in a ^{131}I level scheme involving 52 excited states. The β feeding from the $11/2^-$ ^{131}Te^m to the $7/2^+$ ^{131}I ground state was determined to be (5.2 ± 3.0) % ($\log f_1 t = 10.5$). The isomeric transition branch of $11/2^-$ ^{131}Te^m to $3/2^+$ ^{131}Te^g was

determined to be (22.2 ± 1.6) %. The 6-nsec isomer in ^{131}I at 1797 keV has been assigned as $15/2^-$ and interpreted as a $\pi\nu_1\nu_2$ three–quasiparticle state. The level structure of ^{131}I is interpreted in terms of the shell model and core excitation considerations. (auth)

4982 OBSERVATION OF A 1^+ $(\pi h_{11/2}, \nu h_{9/2})$ STATE IN ^{148}Tb POPULATED IN THE DECAY OF A NEW ISOTOPE, ^{148}Dy. Toth, K.S.; Newman, E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Bingham, C.R.; Rainis, A.E.; Schmidt-Ott, W. Phys. Rev. C 11: No. 4, 1370-1377 (Apr 1975).

A new activity with a half-life of 3.1 ± 0.1 min was observed in bombardments of ^{142}Nd with ^{12}C ions accelerated in the Oak Ridge isochronous cyclotron. A gas-jet-capillary system was used to transport product nuclei to a shielded area so that singles and coincidence γ-ray measurements could be made. Only one transition, 620.2 ± 0.1 keV, was found to be associated with this new activity. It was assigned to ^{148}Dy because (1) the variation of its yield as a function of bombarding energy was the same as for ^{148}Tb γ rays, indicating that an equal number of nucleons were evaporated from the compound system, and (2) it was found to be in coincidence with terbium K x rays. No γ rays were observed in its coincidence spectrum, and no initial growth period was seen for transitions that follow the decay of the ^{148}Tb high-spin isomer. For these reasons the transition very probably proceeds directly to the low-spin isomeric state in ^{148}Tb and establishes an intermediate level at ≈620 keV. The spin and parity of this level has to be 1^+ because the transition from the 0^+ ^{148}Dy ground state has a logft value of 3.9. Our suggestion is that this allowed β decay connects states with the following characters: 0^+ $(\pi h_{11/2}, \pi h_{11/2}) \rightarrow (\pi h_{11/2}, \nu h_{9/2})$. γ-ray data were also obtained for ^{149}Dy and ^{149}Tb^m. From this information the half-life of ^{149}Dy was determined to be 4.1 ± 0.2 min, a value which agrees with recent half-lives reported for this isotope. (auth)

4983 DOUBLE BETA DECAY OF ^{128}Te. Hennecke, E.W.; Manuel, O.K. (Nuclear Division, Department of Chemistry, University of Missouri, Rolla, Missouri 65401); Sabu, D.D. Phys. Rev. C 11: No. 4, 1378-1384 (Apr 1975).

The half-life of ^{128}Te relative to the half-life of ^{130}Te has been found to be $t_{1/2}^{128} / t_{1/2}^{130} = (1.59 \pm 0.05) \times 10^3$ by measurement of the $\beta\beta$-decay products, ^{128}Xe and ^{130}Xe, in a geological old (2.46×10^9 yr) telluride ore. These results yield an upper limit on the lepton nonconservation parameter, $\eta \leq 0.8 \times 10^{-4}$. (auth)

4984 INTERNAL-CONVERSION COEFFICIENT DETERMINATION OF ODD PARITY FOR THE 108.8-keV FIRST-EXCITED STATE OF ^{91}Rb. Wohn, F.K.; Talbert, W.L. Jr.; Weinbeck, R.S.; Glascock, M.D.; Halbig, J.K. (Ames Laboratory-USAEC and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. C 11: No. 4, 1455-1458 (Apr 1975).

Internal conversion coefficients of the 108.0-keV transition in the decay of ^{91}Kr and the 93.6-keV transition in the decay of ^{91}Rb were measured by the electron-to-γ-ray ratio method using a high-resolution magnetic spectrometer and by the x-ray-to-γ-ray ratio method using a low-energy photon spectrometer. The 93.6-keV transition was found to be pure $E2$. The 108.8-keV transition from the first-excited state of ^{91}Rb was found to be pure $M1$, which determines the parity of this state as odd, as expected from spherical shell-model considerations, and contradicts a recently reported assignment of even parity for this state. (auth)

4985 PROTON DECAY OF ANALOG STATES FORMED IN ^{119}Sn$(p,n)^{119}$Sb. Fitzgerald, D.H.; Greenlees, G.W.; Lilley, J.S.; Moss, J.M.; Woods, T. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. Lett. 34: No. 14, 890-892 (7 Apr 1975).

The proton decays of $T_>$ states in ^{119}Sb formed in the reaction ^{119}Sn$(p,n)^{119}$Sb (isobaric analog state) have been studied using a neutron-proton coincidence technique. Analogs of excited states are observed with a total strength which is approximately 50% of that of the cross section to the ground-state analog. These higher analog states decay predominantly with proton energies close to that of the ground-state analog decay. (auth)

4986 TRANSITIONS BETWEEN HIGH-SPIN NUCLEAR STATES. Banaschik, M.V.; Simon, R.S.; Colombani, P.; Soroka, D.P.; Stephens, F.S.; Diamond, R.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 34: No. 14, 892-895 (7 Apr 1975).

We have measured the energy spectra, angular correlations, and number of continuum γ rays following several heavy-ion reactions. A separation of the spectrum into yrast and statistical cascades is clearly indicated for the heavier product nuclei studied ($Z \gtrsim 50$), but is not so obvious for the lighter ones. The yrast cascades associated with three particular reaction channels have been interpreted to give moment-of-inertia values for the highest-spin states in these channels (up to 60 $\hbar$). (auth)

4987 INTERFERENCE BETWEEN DIRECT AND INDIRECT MODES IN TWO-NUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Scott, D.K.; Harvey, B.G.; Hendrie, D.L.; Jahnke, U.; Kraus, L.; Maguire, C.F.; Mahoney, J.; Terrien, Y.; Yagi, K. (Cyclotron Group, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Glendenning, N.K. Phys. Rev. Lett. 34: No. 14, 895-899 (7 Apr 1975).

Direct and indirect transitions to the lowest 2^+ collective states are shown to interfere constructively in the pickup reaction ^{122}Sn(^{16}O, ^{18}O)^{120}Sn at 104 MeV, and destructively in the inverse stripping reaction ^{120}Sn(^{18}O, ^{16}O)^{122}Sn at 99 MeV. (auth)

4988 EXCITED STATES OF THE NEAR-MAGIC NUCLEUS ^{147}Gd. Budzynski, M. (Joint Inst. for Nuclear Research, Dubna, USSR); Bedike, T.; Ion-Mikhai, R.; Marupov, N. Z.; Morozov, V. A.; Muminov, T. M.; Subotovich, M.; Fuya, Kh.; Kholbaev, I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2129-2134(Oct 1974). (In Russian).

The γ–γ angular correlations and the lifetimes of the levels of ^{147}Gd excited during the decay of ^{147}Tb ($T_{\frac{1}{2}}$ = 1.7 hr) were measured. The results are given in graphs and tables, and they are discussed within the framework of the shell model. (5 figures, 3 tables) (JSR)

4989 STRUCTURE OF SPHERICAL STATES OF ODD-NEUTRON NUCLEI WITH A = 145 TO 153 IN LIGHT OF THE ALAGA MODEL. Peker, L. K.; Sigalov, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2119-2122(Oct 1974). (In Russian).

A qualitative analysis was made of the excited states of nuclei with N = 85 to 89 using the Alaga model. It was shown that the Alaga model can be used for a description of the properties of these states. (2 figures, 2 tables) (tr-auth)

4990 DECAY OF ^{118}Sb*. Burmistrov, V. R.; Kartashov, V. M.; Kiselev, B. G.; Kochetkov, V. L.; Novikov, V. P.; Troitskaya, A. G.; Shevelev, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2208-2210(Oct 1974). (In Russian).

In order to make the decay scheme of ^{118}Sb* more precise, the γ spectrum was measured with a coincidence and anticoincidence γ spectrometer and the internal electron conversion spectrum, with a magnetic β spectrometer. The energies and intensities measured are tabulated and incorporated into the decay scheme. The measured and calculated rejection ratios ci and the measured conversion coefficients are tabulated. (2 figures, 3 tables) (JSR)

4991 EXPERIMENTAL COMPLETE FUSION RESULTS. Lefort, M.; Le Beyec, Y.; Peter, J. (Institut Physique Nucleaire, Orsay, France). pp 81-106 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Experimental results of measuring complete fusion cross sections using heavy ion projectiles are presented along with bombarding energies and excitation energies of the compound nuclei. Critical l values above which the probability for complete fusion is negligible are deduced from experimental data and compared with different theoretical approaches. It is shown that new data obtained with heavier ions (Ar) have confirmed that the limit for complete fusion is strongly dependent upon the entrance channel and the energy. (14 figures, 1 table, 56 references) (SDF)

4992 MULTISTEP INELASTIC TRANSITIONS AND HEAVY-ION TRANSFER REACTIONS. Ascuitto, R. J.; Vaagen, J. S. (Yale Univ., New Haven). pp 257-279 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Multistep processes in transfer reactions involving medium weight (56 less than or approximately A less than or approximately 140) and heavy weight (A approximately or greater than 150) nuclei are discussed (CCBA vs. DWBA treatment). It is shown that higher order inelastic processes can play a major role in heavy ion induced transfer reactions and that competition between direct and multistep transitions is important. Preliminary calculations have been carried out for pickup reactions (^{12}C, ^{14}C) on systems ^{154}Sm yields ^{152}Sm and ^{186}W yields ^{184}W. It is concluded that the general structure of the angular distribution near the grazing angle can be a sensitive measure of nuclear structure information when multistep inelastic processes are important. (SDF)

4993 PHYSICAL CHARACTERISTICS OF ^{99m}Tc: CALCULATION OF $E_{\bar{\beta}}$-BAR, GAMMA, AND Δ_γ. Rajput, M. S.; Dubey, D. P. (Punjab Univ., Chandigarh, India). Int. J. Appl. Radiat. Isotop.; 26: No. 1, 35-37(Jan 1975).

In this note calculations of the average β energy, $\bar{E}_{\bar{\beta}}$, the specific γ-ray constant, Γ, and the equilibrium absorbed dose con-

stants, Δ_β, for ^{99m}Tc obtained from its decay characteristics are reported. The E_β and Γ values for this radioisotope have been obtained to be 0.151 MeV/disintegration and 0.2638 R/(hr mCi cm), respectively. Γ is about half the value (0.56 R/hr mCi cm) whereas E_β is 8% higher than previously reported in the literature (0.14 MeV/disintegration). (UK)

4994 ANALOGUE RESONANCES IN ODD ISOTOPES OF ANTIMONY. Arking, R.; Boyd, R. N.; Lombardi, J. C.; Robbins, A. B. (Rutgers–The State Univ., New Brunswick, N. J. (USA). Dept. of Physics). Nucl. Phys., A; 240: No. 2, 235-252(17 Mar 1975).

Differential cross sections and analyzing powers were measured at several angles for protons incident on ^{124}Sn and ^{122}Sn at laboratory energies between 7.2 MeV and 12.0 MeV and on ^{120}Sn between 9.6 MeV and 11.5 MeV. The resonances observed in this energy region correspond to states in ^{125}Sn, ^{123}Sn and ^{121}Sn below 4 MeV excitation. The orbital angular momentum, resonance energy, full width and proton partial width of each resonance were extracted from the cross section excitation functions. The total angular momentum of each resonance was determined from the analyzing-power excitation functions. The present assignments are in good agreement with the results of (d,p) experiments. Optical-model analyses of off-resonance angular distributions measured at several proton energies were used to determine parameters to characterize the off-resonance scattering. Spectroscopic factors were calculated using two approaches: R-matrix theory and the shell-model approach. The two calculations yielded comparable spectroscopic factors for the resonances at lower excitation energies, but the agreement was not so good for the high-lying resonances. Agreement with spectroscopic factors determined from (d,p) reactions is reasonable. Mixing phases calculated with the shell-model approach were in better agreement with experimental mixing phases than those determined with the R-matrix theory. (auth)

4995 G_J-FACTORS AND MAGNETIC HFS INTERACTION CONSTANTS IN THE $6^2P_{\frac{1}{2}}$- AND $8^2P_{\frac{1}{2}}$-STATES OF ^{133}Cs. Abele, J.; Baumann, M.; Hartmann, W. (Tuebingen Univ. (F. R. Germany). Physikalisches Inst.). Phys. Lett., A; 51: No. 3, 169-170(24 Feb 1975).

The hyperfine structures in the $6^2P_{\frac{1}{2}}$- and $8^2P_{\frac{1}{2}}$-states of ^{133}Cs were investigated by optical double resonance in a strong magnetic field. For the gJ-factors and the magnetic hfs coupling constants, the following values are obtained: $gJ(6^2P_{\frac{1}{2}}) = 1.3340(3)$, $a(6^2P_{\frac{1}{2}}) = 50.02(25)$ MHz, $gJ(8^2P_{\frac{1}{2}}) = 1.3342(2)$, $a(8^2P_{\frac{1}{2}}) = 7.644(25)$ MHz. (auth)

4996 QUADRUPOLE MOMENTS OF $\nu h_{11/2}$ STATES IN Sn ISOTOPES AND ELECTRIC FIELD GRADIENTS AT THE Sn AND Cd SITES IN Cd, Sn, AND Sb METAL. Dimmling, F.; Riegel, D. (Freie Univ. Berlin (F. R. Germany). Fachbereich Physik); Rensfelt, K. G.; Herrlander, C. J. (Research Institute for Physics, Stockholm, Sweden). Phys. Lett., B; 55: No. 3, 293-296(17 Feb 1975).

Quadrupole moments of high-spin neutron states in ^{113,114,116}Sn have been determined by means of the TDPAD method. By combining results with previous data, quadrupole moments of isomers in ^{118,119,120}Sn, ^{111}Cd and a series of electric field gradients at the Sn or Cd site in various materials can be derived. (auth)

4997 ANANKE, A NEW PROGRAMME FOR THE RAPID CALCULATION OF THE CORRECTIONS TO THE ANGULAR DISTRIBUTIONS OF ELASTICALLY SCATTERED NEUTRONS. Jeanperrin, C.; Rosier, L. H. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Nucl. Instrum. Methods; 124: No. 1, 243-252(15 Feb 1975). (In French).

This paper describes a new program, ANANKE, to be used to correct experimental neutron elastic scattering angular distributions. This program performs a classical Monte Carlo simulation, but the treatment of the generated information is quite different from the previous ones: a new type of "detection density" has been defined, the use of which allows a considerable gain of computation time. The statistical uncertainty introduced by simulation is evaluated taking into account the correlation between the different simulated variables. This uncertainty appears to be very small. The program has been used to correct angular distributions of 6.4 MeV neutrons scattered by ^{209}Bi, ^{127}I, ^{75}As, ^{59}Co, ^{31}P and ^{12}C, and proved to be very fast. (auth)

4998 FRAGMENTATION OF NUCLEI OF VARIOUS NUCLEON COMPOSITION IN THE INTERACTION WITH 1 GeV PROTONS. Volnin, E. N.; Amalsky, G. M.; Seleverstov, D. M.; Smirnov, N. N.; Vorobyov, A. A. (AN SSSR, Leningrad. Inst. Yadernoj Fiziki); Yakovlev, Yu. P. (Leningradskij Gosudarstvennyj Univ. (USSR)). Phys. Lett., B; 55: No. 4, 409-410 (3 Mar 1975).

The energy spectra of individual isotopes of the elements from helium to carbon produced by the interaction of 1.0 GeV protons with Ti, ^{58}Ni, ^{64}Ni, ^{112}Sn, and ^{124}Sn have been measured at the laboratory angle $\theta = 60°$. The yields of the fragments, normalized to σ_{geom}, were found to be independent of the mass number of the target nuclei with similar values of the number of neutrons to the number of protons ratio. (auth)

4999 THE DECAY OF ^{97g}Rh AND ^{97m}Rh. Plueckebaum, W. Goettingen, Ger.; Univ. Goettingen (1972). 85p. (In German). INIS.

Thesis.

By comparing different γ-spectra, 110 γ transitions, mostly for the first time, were assigned to the decay of ^{97}Rh. Their intensities decreased with two different half-lives. The existence of an isomeric state ^{97m}Rh was thus derived. The half-lives T_g and T_m of the ground state ^{97g}Rh and the isomeric state ^{97m}Rh were measured; the spins and parities I_g and I_m of both of these states were determined from the shell model, paying attention to the empirical data of rhodium isotopes with odd mass number: ^{97g}Rh: $T_g = (30.3 \pm 0.9)$ min and $I_g = 9/2^+$, ^{97m}Rh: $T_m = (47.8 \pm 1.0)$ min and $I_m = 1/2^-$. (GE)

5000 ANISOTROPIC RADIATION, NUCLEAR RESONANCE AND RELAXATION OF ORIENTED, RADIOACTIVE NUCLEI IN MATTER. Ackermann, H. Heidelberg; Univ. Heidelberg (1970). 38p. (In German). INIS.

Thesis.

Polarized isotopes, ^{110}Ag and ^{116}In, were produced by the capture of polarized thermal neutrons. The anisotropy of the β^--radiation was used to determine the polarization and nuclear resonance of the radioactive isotopes. The magnetic moments were measured to be $\mu(^{110}Ag) = 2.7084(5)\ \mu_N$ and $\mu(^{116}In) = 2.7723(10)\ \mu_N$. The influence of the magnetic field and temperature (4.2,..., 77 K) on the β^- anisotropy and spin–lattice relaxation was measured. The quadrupole moment of ^{116}In was estimated in comparison to ^{115}In. (GE)

5001 STUDY OF ISOMERIC STATES AND THEIR VERIFICATION BY PHOTONUCLEAR REACTIONS. Collin, F. W. Brunswick; Univ. Brunswick (1973). 87p. (In German). INIS.

Thesis.

It is shown that the preparation of high-spin states by photonuclear reactions is possible. It appears that high-spin levels are more strongly excited in reactions with the emission of a proton than in (γ,xn) processes. Effective cross-section measurements with separate isotopes led to statements on the multipole absorption and the share of the direct processes. (GE)

5002 (^{3}He,α) REACTIONS WITH NUCLEI WITH HIGH ISOSPIN. Seehars, R. Heidelberg; Univ. Heidelberg (1974). 65p. (In German). INIS.

Thesis.

To investigate the spectroscopic strength in the analog states, the reactions ^{92}Mo, ^{98}Mo, ^{120}Sn(^{3}He,α)^{91}Mo, ^{97}Mo, ^{119}Sn were studied at 28 MeV using a multisplit magnetic spectrograph, and the angular distributions were measured for low- and high-isospin excited states. For all three reactions DWBA computations were carried out with the same optical model parameters. For high-isospin states, the spectroscopic factors were too great in comparison with the sum rule. (GE)

5003 DECAY STUDIES ON SOME SHORT-LIVED ISOTOPES IN THE N = 50 REGION. de Lange, J. C. Amsterdam; Vrije Univ. (1975). 87p.

Thesis.

The results of the decay studies on the following activities are presented: ^{93g}Ru → ^{93}Tc, $T_{\frac{1}{2}} = 59.7$ sec; ^{93m}Ru → ^{93}Tc, $T_{\frac{1}{2}} = 10.8$ sec; ^{92}Ru → ^{92}Tc, $T_{\frac{1}{2}} = 3.65$ min; ^{91}Tc → ^{91}Mo, $T_{\frac{1}{2}} = 3.14$ min (and probably 3.3 min); ^{91g}Mo → ^{91}Nb, $T_{\frac{1}{2}} = 16.6$ min; ^{91m}Mo → ^{91}Nb, $T_{\frac{1}{2}} = 65.1$ sec. The activities ^{93m}Ru and ^{91}Tc were observed for the first time. Systematical trends in the properties of these nuclei and, where possible, comparisons with theoretical calculations are discussed. A remarkable correspondence in the properties of the isotones ^{91}Nb and ^{93}Tc was found. ^{92}Tc was also investigated with the ^{92}Mo (p,nγ)^{92}Tc reaction. An expected $(\pi g_{9/2}) \times (\nu g_{9/2})^{-1}$ multiplet was established. A previously measured mean lifetime of 1.5 μsec was assigned unambiguously to the second excited state in ^{92}Tc. (auth)

5004 THE LEVEL SCHEME OF ^{137}Pr; EVIDENCE FOR PROLATE NUCLEAR SHAPE. Klewe-Nebenius, H.; Habs, D.; Wisshak, K.; Faust, H. (Heidelberg Univ. (F. R. Germany). 2. Physikalisches Inst.); Nowicki, G.; Goering, S.; Rebel, H.; Schatz, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Zyklotronlaboratorium); Schwall, M. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Nucl. Phys., A; 240: No. 1, 137-170(10 Mar 1975).

The level scheme of ^{137}Pr was investigated by means of the γ-rays following the β-decay of ^{137}Nd as well as by prompt γ-rays accompanying (α,xγ) reactions. γ-ray single spectra, $\gamma\gamma$ coincidences (both in-beam and off-beam), angular distributions of

prompt γ-rays and conversion electrons were measured. About 100 γ-rays were assigned to the 38 min decay of ^{137}Nd most of which fit into a scheme of 26 deduced levels. From in-beam experiments an $11/2^-$ level was assigned which is the basis of a strong cascade of stretched E2 transitions with a probable level sequence of $23/2^- - 19/2^- - 15/2^- - 11/2^-$. The interpretation of this cascade in the framework of a strong coupling model indicates a prolate deformation of ^{137}Pr. Another indication for such a deformation was obtained from the very low energy (75 keV) of the first $3/2^+$ level which could not be interpreted in an intermediate coupling model, but is suggested by a Nilsson scheme. (auth)

5005 INELASTIC ELECTRON SCATTERING FROM THE GIANT ISOSCALAR E2-RESONANCE IN ^{142}Nd AND ^{150}Nd. Schwierczinski, A.; Frey, R.; Spamer, E.; Theissen, H. (Technische Univ. Darmstadt (F. R. Germany). Inst. fuer Kernphysik); Walcher, T. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Phys. Lett., B; 55: No. 2, 171-174(3 Feb 1975).

Inelastic electron scattering was used to study the isoscalar E2 giant resonances in ^{142}Nd and ^{150}Nd, which were found at excitation energies of 12.0 and 11.2 MeV with total widths of 2.8 and 5.0 MeV, respectively. The energy shift and the larger width in ^{150}Nd indicate a splitting due to the deformation of ^{150}Nd. (auth)

5006 ON SHORT-RANGE CORRELATION EFFECTS IN ONE- AND TWO-NUCLEON EJECTION BY LIGHT PROBE PARTICLES. Clark, J. W. (Washington Univ., St. Louis, Mo. (USA)); Ristig, M. L. (Koeln Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Phys. Lett., B; 55: No. 2, 149-152(3 Feb 1975).

A unified and consistent approach to the extraction of information on short-range internucleon correlations from (γ,N), (γ,2N), (π,N), (π,2N), and (e,e'N') cross section data is described. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 4907, 4952, 4966, 4969, 4971, 4986, 4989, 5005, 5039, 5053, 5062, 5087, 5140, 5143, 5175, and 5184.

5007 (CEA-N-1700, pp 48-51) TRANSFER REACTIONS INDUCED BY ^{16}O IONS ON SOME RARE EARTHS NEAR THE COULOMB BARRIER. Lamehi-Rachti, M. (Univ., Paris); Levi, C.; Mittig, M.; Papineau, L. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

Excitation functions of ^{16}O induced transfer reactions on ^{152}Sm have been measured. The main object of these transfer reactions is presently the understanding of the optimum Q value angular and energy dependence. Optimum Q values have been calculated including nuclear forces. (auth)

5008 (CEA-N-1700, pp 51-53) MEASUREMENT OF THE ELASTIC SCATTERING OF α PARTICLES ON THE ISOTOPES OF CADMIUM AND TELLURIUM. Badawy, I. (Cairo Univ.); Berthier, B.; Charles, P.; Fernandez, B.; Gastebois, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

Previous measurements of elastic scattering of α particles near 180° at energies close to the Coulomb barrier have been extended to Cd and Te isotopes. A well-defined interaction radius is deduced from an optical model analysis. An analysis of all data in terms of nuclear matter distribution shows that it is possible to determine the point where the nuclear density is about 10^{-3} of the central density. (auth)

5009 (CEA-N-1700, pp 60-62) STUDY OF EXCITED LEVELS IN ^{174}Yb BY PROTON RESONANCE SCATTERING. Lamehi-Rachti, M. (Univ., Paris); Levi, C.; Mittig, W. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

The de-excitation of the well-known $1/2^-$[510] isobaric analogue resonance in ^{175}Lu is investigated in order to get information on the microscopic structure of excited levels of ^{174}Yb. Preliminary experimental results are compared to calculated cross-sections. (auth)

5010 (JINR-P4-8499) ROLE OF COMPONENTS, QUASIPARTICLE PLUS TWO PHONONS, IN THE WAVE FUNCTIONS OF THE NONROTATIONAL LOW-LYING STATES OF DEFORMED NUCLEI. Malov, L. A.; Nesterenko, V. O.; Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The influence of inclusion of components—quasiparticle plus two phonons—into the wave function on the energy and structure of odd-mass nuclei is studied. It is shown that these components can be neglected for the strongly deformed nucleus states with excitation energy below(0.7 to 1.0) MeV. Phonons with $\lambda > 3$ need not be taken into account when calculating the characteristics of the states with the excitation energy < 1 MeV. The above components must be taken into consideration in the wave functions when studying the structure of the nonrotational states of >(1.0 to 1.5) MeV excitation energy. (auth)

5011 (JUL-1164) CHECK OF NUCLEAR DATA WITH A SLOWING DOWN SPECTROMETER. Jonas, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Feb 1975. 97p. (In German). Dep. NTIS (US Sales Only) $8.00.

Thesis. Submitted to Technische Hochschule Aachen, West Germany.

Measurements of effective resonance integrals for natural hafnium performed with the aid of a lead spectrometer and extrapolation to infinite dilution delivered a value $RI_\infty = 2200 \pm 130$ barns for the energy range 0.5 to 18.7 eV. This result is in a remarkable disagreement with calculations performed on the basis of available resonance data. As a result of a sensitivity study and an analysis of the experimental data, a modified set of resonance parameters for hafnium is presented which results in a good agreement between the calculated and measured values of the resonance integral. The slowing-down spectrometer was also used to perform measurements of the effective resonance integral of spherical HTGR fuel assemblies. These measurements were carried out to test a calculation model taking into account the influence of the grain structure on the effective resonance integral caused by the use of cp fuel in HTGR's. It is shown that good agreement between measurement and calculation exists. (32 figures, 6 tables) (auth)

5012 (ORNL-TM-4885, pp 22-23) "ANOMALOUS" GROUND STATES IN THE NEUTRON-DEFICIENT 171 LESS THAN OR EQUAL TO A LESS THAN OR EQUAL TO 185 REGION. Harmatz, B.; Horen, D. J.; Ellis, Y. A. Apr 1975.

In report to the U. S. Nuclear Data Committee.

5013 NEUTRON RESONANCE SPECTROSCOPY: ^{175}Lu. Liou, H.I.; Rainwater, J.; Hacken, G.; Singh, U.N. (Columbia University, New York, New York 10027). Phys. Rev. C 11: No. 4, 1231-1236 (Apr 1975).

Results are given of high-resolution measurements of the neutron resonance parameters (E_0, $g\Gamma_n^0$) for 446 resonances to 3 keV in ^{175}Lu using the Columbia University Nevis synchrocyclotron. The measurements used the 202.05 m flight path for transmission measurements and the 39.57 m flight path for transmission, capture, and self-indication measurements. Values of Γ_γ from (59 ± 20) to (100 ± 20) meV were obtained for 40 levels, with $\langle\Gamma_\gamma\rangle = 77$ meV. The *s*-wave strength function is $10^4 S_0 = (1.83 \pm 0.12)$, and the deduced mean *s*-level spacing is (3.45 ± 0.15) eV. Using recent unpublished *J* assignments for levels below 238 eV by Namenson, Stolovy, and Smith, we obtain (0.55 ± 0.20) for the ratio of the $J = 4$ to $J = 3$ *s* strength functions. The results to 200 eV agree with values expected from the orthogonal ensemble theory for level spacing systematics. (auth)

5014 GIANT RESONANCE REGION OBSERVED IN ^{3}He SCATTERING BY ^{144,154}Sm, ^{159}Tb, ^{165}Ho, ^{169}Tm, AND ^{208}Pb. Horen, D.J. (Institut des Sciences Nucléaires, BP 257, 38044 Grenoble, France and Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Arvieux, J.; Buenerd, M.; Cole, J.; Perrin, G.; de Saintignon, P. Phys. Rev. C 11: No. 4, 1247-1250 (Apr 1975).

The giant resonance regions of ^{144,154}Sm, ^{159}Tb, ^{165}Ho, ^{169}Tm, and ^{208}Pb have been investigated by inelastic scattering of 80-MeV ^{3}He ions. The shapes of the resonance structure were observed to be quite similar for each target studied here. Comparison of the experimental cross sections with energy-weighted sum rules implies that the observed structure is probably comprised of more than just an isoscalar *E2* excitation. (auth)

5015 PROPERTIES OF THE EXCITED STATES IN ^{171}Tm. Gopinathan, K.P.; Patel, S.B. (Tata Institute of Fundamental Research, Bombay-400 005, India). Phys. Rev. C 11: No. 4, 1364-1369 (Apr 1975).

Angular correlations of the 277.4-210.5 keV and the 371.9-277.4 keV γ-γ cascades in ^{171}Tm populated in the decay of the 7.5 h ^{171}Er have been measured to be $W(\theta)_{277.4-210.5} = 1 + (0.124 \pm 0.005) P_2(\cos\theta)$ and $W(\theta)_{371.9-277.4} = 1 + (0.018 \pm 0.012) P_2(\cos\theta)$. The result for the first cascade, combined with the existing data on high-resolution internal conversion measurements, establishes the spin of the 635.4-keV level to be 7/2, corresponding to the $7/2^+$ [404] Nilsson state. The spins of the 912.8-keV (5/2) and the 1284.7-keV (5/2) levels are in agreement with the angular correlation measurements. The multipole mixing ratios of the transitions are deduced to be: 210.5 keV–*E*1 + (≲0.06) %*M*2; 277.4 keV–*M*1 + (10 ± 1) %*E*2; and

371.9 keV—$M1$ + (9 ± 3) %$E2$. The half-life of the 635.4-keV level has been measured by the γ-γ delayed coincidence method to be $T_{1/2}$ = 1.26 ± 0.06 nsec. The identity of the delayed level has been confirmed by the delayed gating technique. The transition probability of the 210.5-keV $E1$ transition has been evaluated and compared with the theoretical estimate and that of similar transitions in other nuclei in the region. (auth)

5016 STATES IN ^{184}W VIA NEUTRON CAPTURE AND BETA-DECAY EXCITATIONS. Bushnell, D.L.; Hawkins, J.; Goebbert, R. (Physics Department, Northern Illinois University, DeKalb Illinois 60115); Smither, R.K. Phys. Rev. C 11: No. 4, 1401-1421 (Apr 1975).

Thermal neutron capture and average resonance neutron capture in ^{183}W yield two different γ-ray spectra made up of high-energy primary transitions from the capture state to low-lying levels in ^{184}W. These spectra along with medium-energy spectra following thermal capture and γ-γ coincidence spectra produced from β decay of ^{184}Re provides the basis for the study of 43 states in ^{184}W ranging in energy up to 2404 keV. A level scheme has been constructed that incorporates 50 γ rays having energies ranging from 600 to 2400 keV. Five energy levels not previously reported in the literature have been discovered, and J^π assignments for over six other levels have been improved, so that parities are certain in most cases while spin choices are narrowed to at most two. All positive-parity states below 2404 keV having spins 0, 1, or 2 have been detected, and most if not all have been given a definitive positive parity assignment. In addition, many negative-parity states having low spin values have been identified. Disagreements with J^π assignments previously reported in the literature are discussed. (auth)

5017 PROPERTIES OF THE COLLECTIVE STATE OF ISOTOPES OF Sm AND Gd, LYING IN THE TRANSITION REGION OF NUCLEI. Dzholos, R. V.; Denau, F.; Kartavenko, V. G.; Yanssen, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2059-2064(Oct 1974). (In Russian).

An analysis was made of the isotopes of Sm and Gd, lying in the transition region of nuclei, in the framework of the microscopic nuclear model. Since experimental data clearly show the collective nature of the low-lying levels in these nuclei, the problem is formulated in the following manner. From the Hamiltonian of the microscopic nuclear model, that part is separated which describes only the states belonging to the collective quadrupole excitation branches. The isotopes analyzed are ^{150}Sm, ^{152}Sm, and ^{152}Gd. (2 figures, 1 table) (JSR)

5018 NUCLEI FAR FROM THE REGION OF β STABILITY. Westgaard, L. (CERN, Geneva). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2025-2035(Oct 1974). (In Russian).

A review is given of the experimental methods and techniques used at the ISOLDE installation to study nuclei far from the region of β stability. Examples of the results obtained on nuclear masses, spin, magnetic moments, and dimensions, on the systematics of α decay, and detailed nuclear spectroscopy are given. (10 figures, 1 table, 49 references) (JSR)

5019 LEVELS OF ^{185}Os AND ^{187}Os EXCITED IN (n,γ) REACTIONS. Prokof'ev, P. T.; Simonova, L. I. (Inst. of Physics, Riga). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2135-2140(Oct 1974). (In Russian).

On the basis of data obtained from (n,γ) reactions and the results of other studies, the neutron binding energy in ^{185}Os was determined to be B_n = 6625.4(9) keV. The energy level schemes of ^{185}Os and ^{187}Os were enlarged. (2 figures, 1 table) (tr-auth)

5020 SYSTEMATICS OF HIGH SPIN PHENOMENA. Ward, D. (Chalk River Nuclear Labs., Ont.). pp 417-436 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The subject matter of this paper is restricted to fairly well deformed, even-even nuclei in the general area of the rare earths, i.e., 150 less than A less than 200. The anomalous behavior of high-spin rotational states is discussed in terms of the experimental observation of crossing bands. Then the experimental techniques used in identifying high-spin states are mentioned, and the current status of measurements to determine properties of high-spin states (transition probabilities and g factors) are reviewed. Finally, new results on high-spin states in odd-mass systems are discussed insofar as they give an indication of the microscopic structure of high-spin states in the neighboring even nuclei. (16 figures) (RWR)

5021 THEORETICAL ASPECTS OF HIGH SPIN PHENOMENA. Faessler, A. (Kernforschungsanlage, Juelich, Ger.). pp 437-457 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

A brief history of the backbending phenomenon is given, and then theoretical explanations for this effect are examined. These include backbending due to the crossing of two rotational bands, backbending due to the deformation energy surface, the Coriolis antipairing effect, and the alignment effect. The "second" band and odd-mass nuclei are discussed. Sometimes both protons and neutrons contribute to backbending. It is concluded that backbending is not yet fully understood. Practically all feasible explanations, however, agree that it is caused by the crossing of two rotational bands. The most probable explanations, at least for the rare earths, are felt to be the Coriolis antipairing and the alignment effect. Some previously unreported work from Juelich is presented. (19 figures) (RWR)

5022 STUDIES OF NUCLEI FAR FROM STABILITY WITH HEAVY IONS. Hamilton, J. H. (Vanderbilt Univ., Nashville, TN). pp 501-528 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Studies of nuclei far from stability with the new on-line mass separators can involve important new phenomena. The significant problems associated with these studies are sketched and illustrated with some of the recent data obtained. Measurements of nuclear masses are discussed first; it is seen that the various mass predictions do not always give good agreement with experiment as one goes to nuclei farther and farther from stability. Beta-delayed proton emission and positron decay rates are then reviewed. Alpha and proton radioactivities are briefly considered; no true proton decay of ground states has yet been found. The last and largest part of the paper deals with gamma-ray and conversion electron spectroscopy and new evidence for coexistence of spherical and deformed shapes. (23 figures, 9 tables, 131 references) (RWR)

5023 γ RADIATION OF ^{160}Ho. Aleksandrov, A. A.; Buttsev, V. S.; Vylov, Ts.; Grigor'ev, E. P.; Gromov, K. Ya.; Kalinnikov, V. G.; Lebedev, N. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2096-2102(Oct 1974). (In Russian).

The energies and intensities of the γ radiation of ^{160}Ho* + ^{160}Ho were measured with a Ge(Li) detector with a resolution of 2.9 to 3.5 keV, and the results are tabulated. Data on the K conversion coefficient and the multipolarities of many of the lines are also tabulated. The search for isomeric transitions and states in ^{160}Ho is described. (1 table) (JSR)

5024 DECAY OF ISOMERS OF ^{160}Ho AND PROPERTIES OF ^{160}Dy. Aleksandrov, A. A.; Buttsev, V. S.; Vylov, Ts.; Grigor'ev, E. P.; Gromov, K. Ya.; Kalinnikov, V. G.; Lebedev, N. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2103-2111(Oct 1974). (In Russian).

On the basis of previously obtained data on the decay of ^{160}Ho, decay of ^{160}Tb, Coulomb excitation, and in (d,d'), (p,t), and α-particle reactions, very precise data were obtained on the energy, spin, parity, and rotational bands of clearly established levels of ^{160}Dy. These data are tabulated and the peculiarities of many of the levels are discussed. Levels excited in (d,d') reactions and possibly in the decay of ^{160}Ho are tabulated separately. Data from the study of the decay of ^{160g}Ho were statistically analyzed, and the levels were arranged according to the energy balance of the γ transitions. (3 figures, 3 tables) (JSR)

5025 K-FORBIDDEN TRANSITIONS IN ^{169}Tm. Enulesku, A.; Pitiku, I.; Vavicheta, I. (Inst. of Atomic Physics, Bucharest). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2090-2095(Oct 1974). (In Russian).

The lifetimes of the $^7/_2^-$ [523] level at 379 keV and the $^7/_2^+$ [404] level at 316 keV were measured with precision, and the factors of forbiddenness for the de-excitation transitions observed for each level were calculated. Values of $T_{\frac{1}{2}}$ = 54.1 ± 0.5 ns and 665 ± 5 ns were obtained for the 379- and 316-keV levels, respectively. The reasons for the high factors of forbiddenness obtained for most transitions were discussed. (4 figures, 2 tables) (JSR)

5026 TRANSITION PROBABILITIES AND BAND MIXING IN DEFORMED NUCLEI WITH AN ODD NUMBER OF NEUTRONS. Andrejtscheff, W. H.; Winter, G.; Seidel, W.; Manfrass, P.; Prade, H.; Schilling, K. D. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2161-2166(Oct 1974). (In Russian).

Calculations of the parameters of band mixing were made for ^{161,163,165}Er, taking into consideration the important aspects of the

experimentally known probabilities of electromagnetic transitions. Some results of these calculations for excited states of ^{165}Er are tabulated and discussed. (1 figure, 3 tables) (JSR)

5027 SELF CONSISTENT CALCULATIONS AND QUADRUPOLE MOMENTS OF EVEN Sm ISOTOPES. Decharge, J.; Girod, M.; Gogny, D. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Phys. Lett., B; 55: No. 4, 361-364(3 Mar 1975).

Complete H−F calculations have been performed for several even Sm isotopes. Binding energies as a function of deformation and quadrupole moments obtained show that the H−F method using the D1 interaction is a reliable approach to study nuclear deformations. (auth)

5028 FIRST INVESTIGATIONS IN THE UNISOR PROGRAM. New Isotopes of ^{188}Tl, ^{189}Tl, and ^{116}I. Decay Schemes of ^{189,190}Tl, ^{117}Xe, and ^{117}I. Atomic and Nuclear Investigations Outside the Beam. Hamilton, J. H.; Spejewski, E. H.; Mlekodaj, R. L. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2036-2053(Oct 1974). (In Russian).

The first investigate work carried out and completed by 1973 at the UNISOR installation is described. New data on the decay of the known isotopes ^{189}Tl, ^{190}Tl, ^{116}Xe, and ^{117}Xe−^{117}I−^{117}Te are reported. Studies on properties of the new nuclides ^{116}I, ^{188}Tl, and ^{186}Tl are discussed. Measurements of nuclear g factors and experiments in atomic physics not connected with on-line operation with the accelerator are also briefly described. (11 figures, 7 tables) (JSR)

5029 SHAPE-PHASE TRANSITIONERS AS PAIRING BACK BENDERS. Perazzo, R. P. J.; Reich, S. L. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Phys. Lett., B; 55: No. 4, 354-356(3 Mar 1975).

A semiclassical analysis of pairing vibrational and rotational bands is performed. The empirical pairing moment of inertia is found to present a "back bending" behavior whenever a shape-phase transition takes place. A phenomenological calculation for the Sm isotopes is performed. (auth)

5030 NEGATIVE PARITY STATES OF ^{152}Gd IN THE MODEL OF OCTUPOLE PHONONS WEAKLY COUPLED TO A DEFORMED CORE. Nomura, M. (Tokyo Univ. (Japan). Coll. of General Education). Phys. Lett., B; 55: No. 4, 357-360(3 Mar 1975).

The characteristic energy spacing of negative-parity states in ^{152}Gd is explained in the model of octupole phonons weakly coupled to a deformed core. Adjusting one coupling strength yields a surprisingly good fit to the observed energy spectra. (auth)

5031 ON OBLATE−PROLATE TRANSITION IN THE GROUND STATE ROTATIONAL BAND OF LIGHT MERCURY ISOTOPES. Frauendorf, S.; Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). Phys. Lett., B; 55: No. 4, 365-368(3 Mar 1975).

The transition from an oblate to a prolate shape in the ground-state band of even-mass Hg isotopes and in the ground states of the chain of odd-mass Hg isotopes is studied. The shape is found by minimizing the deformation energy, which is calculated by means of Strutinsky's shell-correction method. The rotational energy corresponds to the axial-symmetric rotator. The moment of inertia is calculated with the help of the cranking model. Pairing and hexadecupole deformation are included. The results are in good agreement with the available experimental data. (auth)

5032 ROTATIONAL BAND-STRUCTURES IN TRANSITIONAL ODD-A NUCLEI. Meyer ter Vehn, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Phys. Lett., B; 55: No. 3, 273-276(17 Feb 1975).

A triaxial rotor model describes all known high- and low-spin states of unique parity based on the $h_{9/2}$ shell in ^{187}Ir and ^{195}Au. Very low-lying quasi-γ-bands are shown to exist in the triaxial region. (auth)

5033 INELASTIC NUCLEAR−COULOMB INTERFERENCE AND DIRECT-TWO-STEP INTERFERENCE IN HEAVY-ION INDUCED TWO-NUCLEON TRANSFER REACTIONS ON RARE-EARTH NUCLEI. Ascuitto, R. J.; Vaagen, J. S.; Erb, K. A.; Hanson, D. L.; Bromley, D. A. (Yale Univ., New Haven, Conn. (USA). Nuclear Structure Lab.); Kolata, J. J. (Brookhaven National Lab., Upton, N. Y. (USA)). Phys. Lett., B; 55: No. 3, 289-292(17 Feb 1975).

The almost pure two-step population of the 2^+ ground-state rotational band member of ^{184}W in the two-neutron transfer reaction ^{186}W(^{12}C, ^{14}C)^{184}W, resulting in an angular distribution characterized by a dramatic nuclear−Coulomb interference minimum in the vicinity of the grazing angle, is compared with the corresponding angular distribution for the two-proton transfer reaction ^{186}W(^{12}C, ^{10}Be)^{188}Os, where the interference minimum is shown to arise primarily from direct-two-step (nuclear-dominated) interference. (auth)

5034 MEASUREMENTS OF SOME K-INTERNAL CONVERSION COEFFICIENTS NEAR THRESHOLD. Visvanathan, A.; Funk, E. G.; Mihelich, J. W. (Notre Dame Univ., Ind. (USA). Dept. of Physics). Z. Phys.; 271: No. 4, 339-343(Dec 1974).

The K-internal conversion coefficients have been measured by the XPG technique for a number of low-energy γ-ray transitions whose energies do not exceed the K-binding energies by more than 4 keV. Using Si(Li) detectors in singles and coincidence arrangements, the following results were obtained: 63.1-keV E1 in ^{169}Tm(α_K = 1.02 ± 0.15), 72.0-keV E1 in ^{187}Re (0.75 ± 0.05), 57.8-keV M1 in ^{162}Ho(11.42 ± 0.67), 56.6-keV M1 in ^{166}Ho(12.04 ± 0.70), and 67.1-keV M1 in ^{174}Lu(10.25 ± 0.58). The experimental results are compared with the theoretical calculations which include transition energies down to 1 keV above threshold. (auth)

5035 INFLUENCE OF PARTICLE NUMBER PROJECTION AND RESIDUAL INTERACTION ON THE YRAST BANDS IN RARE EARTH NUCLEI. Gruemmer, F.; Schmid, K. W.; Faessler, A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik). Nucl. Phys., A; 239: No. 2, 289-300(24 Feb 1975).

A microscopic study of the yrast bands of various doubly even nuclei in the rare earth region is presented. The calculations are based on a variational principle using angular momentum and particle number projected deformed BCS states as trial wave functions and the pairing plus quadrupole force as residual interaction. The influence of particle number projection and force parameters on the spectra and wave functions are studied as well as the interplay between Coriolis antipairing and deformation effects. Successes and shortcomings of the model are discussed. (auth)

5036 NEUTRON EMISSION FOLLOWING MUON CAPTURE IN HEAVY NUCLEI. Hadermann, J. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Phys. Lett., B; 55: No. 2, 141-143(3 Feb 1975).

The energy distribution of neutrons following muon capture in heavy nuclei is investigated. It is shown that the experimental high energy tail (E > 10 MeV) of the neutron distribution can be explained by a direct emission process. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 4578, 4818, 4858, 4907, 4997, 5014, 5018, 5020, 5028, 5032, 5036, 5062, 5087, 5140–5143, 5159, and 5192.

5037 (CEA-N-1700, pp 108-112) ($\vec{d}$,^{3}He) AND ($\vec{d}$,t) REACTIONS INDUCED BY POLARIZED DEUTERONS. Mayer, B. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972−30 September 1973.

Angular distributions of cross sections and vector analyzing powers were measured in ^{208}Pb($\vec{d}$,^{3}He)^{207}Tl, ^{208}Pb($\vec{d}$,t)^{207}Pb, ^{12}C($\vec{d}$,^{3}He)^{11}B and ^{12}C($\vec{d}$,t)^{11}C reactions. The vector analyzing powers exhibit strong j-dependence both in ($\vec{d}$,^{3}He) and ($\vec{d}$,t) reactions. The distorted-wave Born-approximation accounts qualitatively for the reactions on ^{208}Pb, but no good fit was achieved for the vector analyzing powers in the reactions on ^{12}C. The angular distributions for the ^{12}C($\vec{d}$,^{3}He)^{11}B and ^{12}C($\vec{d}$,t)^{11}C mirror reactions are quite similar. (auth)

5038 (ORNL-TM-4885, pp 10-11) GAMMA-RAY PRODUCTION DUE TO NEUTRON INTERACTIONS WITH ^{208}Pb FOR E/sub gamma/ BETWEEN 5 AND 8 MeV. Dickens, J. K. Apr 1975.

In report to the U. S. Nuclear Data Committee.

5039 (RLO-1388-258, pp 65-67) HIGHLY INELASTIC DEUTERON SCATTERING AT 45 MeV. Halpern, I.; Hendrie, D.; Wieman, H.; Zisman, M. S. Jun 1974.

In annual report, 1974.

5040 (RLO-1388-258, pp 81-85) ANALYZING POWER IN THE ^{208}Pb(p,$\vec{p}_0$)^{208}Pb REACTION NEAR THE $3p_{\frac{1}{2}}$ ISOBARIC ANALOG RESONANCE. Baker, M. P.; Blair, J. S.; Cramer, J. G.; Trainor, T. A.; Weitkamp, W. G. Jun 1974.

In annual report, 1974.

5041 (RLO-1388-258, pp 85-88) SPECTROSCOPIC ANALYSIS OF PROTON ELASTIC SCATTERING FROM ^{208}Pb NEAR THE LOW-LYING ISOBARIC ANALOG RESONANCES. Baker, M. P.; Blair, J. S.; Cramer, J. G.; Weitkamp, W. G. Jun 1974.

In annual report, 1974.

5042 (RLO-1388-258, pp 145-150) EVIDENCE FOR A COLLECTIVE E2 RESONANCE IN THE REACTION ^{208}Pb(p,γ)^{209}Bi.

Brown, D. R.; Ebisawa, K.; Paul, P.; Snover, K. A. Jun 1974. In annual report, 1974.

5043 MEASUREMENTS OF THE CAPTURE CROSS-SECTION OF ^{197}Au BETWEEN 75 keV AND 500 keV. Fort, E.; Le Rigoleur, C.; Arnaud, A.; Taste, J.; Huet, J. L.; Maloizel, J. (CEN de Cadarache, France). pp 239-254 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The capture cross section of ^{197}Au has been measured between 75 keV and 500 keV by two methods. (1) Prompt γ ray cascades immediately following neutron capture were detected with a liquid scintillator. The total-energy weighting technique of Maier-Leibnitz was used to render the detector response insensitive to details of the γ ray cascade. Neutrons were produced with a pulsed Van de Graaff using the ^{7}Li(p,n)^{7}Be reaction, and neutron flux was monitored with a ^{10}B–NaI(Tl) detector. (2) In the activation measurements, neutrons were produced with a continuous proton beam on a lithium target by the ^{7}Li(p,n)^{7}Be reaction. The neutron flux was monitored with a BF_3 counter of known efficiency. The activities of gold samples irradiated at different distances from the neutron source were determined absolutely by β-γ coincidence counting and relatively by γ-counting. The measurements by the two methods disagree for unknown reasons. The cross sections obtained by prompt gamma counting are more consistent with existing data and at present appear more reliable than the activation data. (6 figures) (auth)

5044 ENERGY SPECTRA OF PHOTONEUTRONS FROM HEAVY ELEMENTS. Evseev, V. S.; Mamedov, T. N.; Selyugin, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 245-250(Feb 1975). (In Russian).

Energy spectra of neutrons in the energy range $2 \leq E_n \leq 5$ MeV are measured in the photoexcitation of nuclei Ta, Pb, Bi and Th by bremmstrahlung γ-quanta with upper energy value of 34 MeV. The neutron spectra are used to define the quantity $\overline{T}$ – the nuclear temperature after emission of the first neutron. $\overline{T} = 1.01 \pm 0.04$; 1.12 ± 0.04; 1.11 ± 0.04 and 1.25 ± 0.05 for Ta, Pb, Bi and Th correspondingly. Comparison of the obtained values of the nuclear level density parameter with predictions of the statistical theory of nuclear reactions shows that the theory does not describe the decay of nuclear collective states of the kind of the giant dipole resonance. (auth)

5045 DETERMINATION OF THE REACTION THRESHOLDS AT BOMBARDMENT OF THE NUCLEI ^{208}Pb AND ^{238}U BY THE IONS ^{40}Ar AND ^{52}Cr. Oganesyan, Yu. Ts.; Penionzkevich, Yu. E.; Gavrilov, K. A.; Kim De En. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 239-244(Feb 1975). (In Russian).

Production cross sections were studied for the fission fragments on thin targets ^{208}Pb and ^{238}U, depending on the energy of the bombarding ions ^{40}Ar and ^{52}Cr. In case of the reaction ^{238}U + ^{40}Ar the energy dependences were also studied for production yields in the reactions with transfer of several nucleons. Using the obtained dependences, the Coulomb barrier of the interacting nuclei was determined as well as the corresponding effective interaction range, that was found to be constant for all the reactions in view and equals to 1.44 ± 0.02 f. The obtained data are compared with results of various calculations. (auth)

5046 RECOIL PROPERTIES OF ^{24}Na AND ^{28}Mg FORMED BY THE INTERACTION OF ^{197}Au AND ^{238}U WITH 3–300-GeV PROTONS. Kaufman, S.B.; Weisfield, M.W. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 11: No. 4, 1258-1264 (Apr 1975).

The recoil properties of ^{24}Na and ^{28}Mg formed by the interaction of protons of energy 3.0–300 GeV with targets of gold and uranium have been measured by a thick-target technique. γ-ray spectroscopy without chemical separation was used to measure the nuclides of interest. The forward-to-backward ratio (F/B) of both nuclides from both targets exhibits a maximum near 3 GeV, decreasing from a value of about 2.0 at that energy to about 1.3 at 300 GeV. This behavior is strikingly similar to that of several neutron-deficient medium-mass nuclides formed from uranium, such as ^{131}Ba, and seems to indicate that both types of products are formed in similar processes. The mean ranges of the light nuclides were found to decrease by about 25% from 3 to 300 GeV, also similar to the behavior of the neutron-deficient products, although smaller in magnitude. (auth)

5047 GOLD NEUTRON-CAPTURE CROSS SECTION FROM 3 TO 550 keV. Macklin, R.L.; Halperin, J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Winters, R.R. Phys. Rev. C 11: No. 4, 1270-1279 (Apr 1975).

A careful remeasurement of the ^{197}Au(n, γ) cross section using the pulse height weighting technique in small scintillators has been completed. The 4.9 eV resonance was used for calibration, and the ^{6}Li(n, α) cross section, for flux shape. Estimated errors range from 1.4% near 30 keV to 3.3% at 550 keV. Individual resonance parameters were deduced in the 2.6–4.9 keV range, and the fluctuations over 10's of resonances were analyzed below 90 keV. The fluctuations are larger than expected, limiting the precision attainable with monoenergetic sources using this standard. The fluctuation intensity appears to indicate intermediate resonance structure in the compound nucleus with $\approx$10 keV width and $\approx$40 keV spacing. (auth)

5048 DECAYS OF ^{211}At, ^{211}Po, AND ^{207}Bi. Jardine, L.J. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 11: No. 4, 1385-1391 (Apr 1975).

The energies and intensities of γ rays and internal-conversion electrons from the electron-capture decay of ^{211}At and from the α decays of ^{211}At and ^{211}Po have been measured. A new first-forbidden electron-capture branch of ^{211}At is reported. First-forbidden electron-capture transition rates are discussed with reference to the $2g_{9/2}$ and $1i_{11/2}$ neutron states in ^{211}Po. γ rays corresponding to the l-forbidden $M1$ transitions $\nu(3p_{3/2})^{-1} \rightarrow \nu(2f_{5/2})^{-1}$ in ^{207}Pb and $\nu(1i_{11/2}) \rightarrow \nu(2g_{9/2})$ in ^{211}Po have been observed. The α spectra of ^{211}At and ^{211}Po and the energies and relative intensities of γ rays from the electron-capture decay of ^{207}Bi have been remeasured. A level scheme incorporating all of these decays is given. (auth)

5049 SEMIMICROSCOPIC DESCRIPTION OF ODD At ISOTOPES. Paar, V. (Institute Rudjer Bošković, Zagreb, Yugoslavia). Phys. Rev. C 11: No. 4, 1432-1442 (Apr 1975).

The properties of odd At isotopes have been described by coupling three valence-shell protons to the quadrupole vibrational field. Qualitative and quantitative results have been compared with recent experimental data from the Dubna and Stockholm groups. It is interesting to note that two lowest $7/2^-$ states exchange their character in At nuclei away from the $N = 126$ shell closure. This pronounced feature of At isotopes is a combined effect of the particle-vibration coupling and the Pauli principle. (auth)

5050 GIANT MULTIPOLE RESONANCES AND THE THREE-FLUID HYDRODYNAMICAL MODEL OF NUCLEI. Biedenharn, L.C.; Trivedi, M. (Department of Physics, Duke University, Durham, North Carolina 27706); Danos, M. Phys. Rev. C 11: No. 4, 1482-1484 (Apr 1975).

The recently observed resonance at $\approx$11 MeV in ^{208}Pb is interpreted as the miniature quadrupole resonance (associated with the giant quadrupole resonance at 22 MeV) implied by the three-fluid hydrodynamical model. A difficulty arises with the miniature dipole resonance; this may signify that the simple hydrodynamic model has reached the limits of its validity. A numerical error in a previous publication is corrected. (auth)

5051 STUDY OF THE ^{209}Bi(γ,n)^{208}Bi REACTION AT 9 MeV. McFee, J. E.; Ishaq, A. F. M.; Kennett, T. J.; Prestwich, W. V. (McMaster Univ., Hamilton, Ontario (Canada). Dept. of Physics). Phys. Lett., B; 55: No. 4, 369-372(3 Mar 1975).

A system employing monoenergetic neutron capture photons and a high-resolution ^{3}He spectrometer has been developed to investigate photoneutron reactions. Using this system, a preliminary study of the ^{209}Bi(γ,n)^{208}Bi reaction has been done. (auth)

5052 GAMMA SPECTROSCOPY AFTER ^{13}C INDUCED ONE-NEUTRON-TRANSFER REACTIONS WITH ^{90}Zr AND ^{208}Pb. Haberkant, E. K. Heidelberg; Univ. Heidelberg (1973). 61p. (In German). INIS.

Thesis.

The sub-Coulomb transfer reactions ^{90}Zr(^{13}C, ^{12}C)^{91}Zr, ^{208}Pb(^{13}C,^{12}C)^{209}Pb and ^{208}Pb(^{13}C,^{14}C)^{207}Pb were investigated by gamma spectroscopy of the residual nuclei using Ge(Li) detectors. Integrated transfer cross sections of several millibarns show that the tunnel effect of a neutron is the dominating process a few MeV below the Coulomb barrier. Excitation functions for back-scattering for the reaction ^{90}Zr(^{13}C,^{12}C)^{91}Zr in the energy range 31 MeV $\leq E_{^{13}C} \leq$ 36 MeV were measured by ^{12}C – γ-coincidence using the energy loss in a thick target. (GE)

5053 PHOTOPRODUCTION OF HIGH-ENERGY NEUTRONS AT THICK TARGETS WITH ELECTRONS IN THE ENERGY RANGE FROM 150 MeV UP TO 266 MeV. Eyss, H. J. Mainz; Univ. Mainz (1971). 184p. (In German). INIS.

Thesis.

For a fixed emission angle of 90° and for $E_n \geq 12$ MeV, the following were determined with a linear accelerator: (1) the differential neutron production cross-sections for a thick lead target as a function of the primary electron energy between 150 and 266 MeV; (2) the dependence of the differential effective cross-section on the mass number A by measurements on C, Al, Cu, Cd and Pb targets at the primary electron energy E_e = 234 MeV, and (3) the differential neutron production rate as a function of the depth of the lead target at E_e = 234 MeV. (GE)

5054 K-CONVERSION OF THE M3 TRANSITION NEAR THRESHOLD ENERGY IN ^{191}Os. Campbell, J. L.; O'Brien, P. (Guelph Univ., Ontario (Canada). Dept. of Physics). Nucl. Phys., A; 240: No. 1, 1-12(10 Mar 1975).

The intensity ratio of K and L x-rays arising from internal conversion of the 74.38-keV M3 isomeric transition in ^{191}Os was measured with a thin source made by electron microscopy staining techniques. The resulting $\alpha_K = 119 \pm 12$ agrees with the theoretical value of 115 calculated using a nuclear structure parameter $\lambda = 9.4 \pm 0.5$. No anomaly due to proximity of the transition energy to threshold was observed. (auth)

5055 ELECTROMAGNETIC TRANSITION RATES IN ^{208}Pb. Kortelahti, M.; Pakkanen, A.; Kantele, J. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Nucl. Phys., A; 240: No. 1, 87-97(10 Mar 1975).

Intensities of γ-ray transitions in ^{208}Pb were determined by double and triple-coincidence studies of the decay of ^{208}Tl(ThC''). The measured branching ratios are compared with those calculated from theoretical and empirical wave functions of the levels of ^{208}Pb. The empirical wave functions give better agreement with the present results. In the calculations, use was made of experimentally determined or theoretical M1 and E2 single-particle transition matrix elements. (auth)

5056 ON THE FISSION WIDTH OF ISOBARIC ANALOGUE STATES. Yadrovskii, E. L. (Institute of Physics and Power Engineering, Obninsk, USSR). Phys. Lett., B; 55: No. 2, 157-158 (3 Feb 1975).

The experimental cross sections of the reactions ^{209}Bi(p,f) and ^{206}Pb(α,f) are analyzed to estimate the ratio Γ_f/Γ_{tot} for the IAS. From the comparison of the values Γ_f for the nuclear states with different isospins it follows that strong isospin effects exist in the nuclear fission process involving ^{210}Po. (auth)

5057 POTENTIALS FOR HEAVY IONS SCATTERING FROM ^{208}Pb. Satchler, G. R. (Oak Ridge National Lab., Tenn. (USA)). Phys. Lett., B; 55: No. 2, 167-170(3 Feb 1975).

Data for the elastic scattering of ^{12}C(96 MeV), ^{16}O(129.5 and 192 MeV) and ^{20}Ne (161.2 MeV) from ^{208}Pb were used to deduce properties of the ion-ion potential. In particular, the strength of the absorptive potential in the surface region was found to be comparable to that of the real potential. The importance of small-angle data is emphasized. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 3526, 4578, 4773, 4774, 5010, 5022, 5036, 5044–5046, 5117, and 5214.

5058 (CEA-N-1700, pp 238-240) ^{241}Am TOTAL AND FISSION CROSS SECTIONS. Derrien, H.; Lucas, B.; Trochon, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The total and fission cross sections of ^{241}Am were studied. The measured mean spacing is 0.67 eV but about 30% of the level are missed. The strength function value and radiative width are found in agreement with the predictions. The fission widths do not fluctuate very strongly exhibiting a number of degrees of freedom of 5 ± 2. (auth)

5059 (CEA-N-1700, pp 240-242) NEUTRONS AND γ RAYS EMITTED DURING FISSION. Frehaut, J. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France); Shackleton, D.; Trochon, J. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Some characteristic values for the ^{239}Pu(n,γf) are deduced from the fluctuations of the number of neutrons and the energy of the γ-rays emitted in the 1^+ fission resonances of ^{239}Pu. The fluctuations for ^{235}U are very weak in agreement with the small expected values of $\Gamma(\gamma f)$. (auth)

5060 (CEA-N-1700, pp 259-260) STUDY OF THE ORIGIN OF THE HIGH SPIN VALUES OF FISSION FRAGMENTS. Poitou, J.; Signarbieux, C. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

Experimental data obtained on variances of the prompt neutron number distributions for ^{252}Cf spontaneous fission show that the fragments could acquire most of their spin by Coulomb excitation after scission. (auth)

5061 (CEA-N-1700, pp 260) STUDY OF THE CHANGE IN THE MEAN NUMBER OF PROMPT NEUTRONS WITH THE TOTAL MEAN ENERGY OF PROMPT GAMMA RAYS. Girard, J.; Ribrag, M. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972–30 September 1973.

The mean total energy for four fissioning systems of the prompt gamma-rays and the mean number of prompt neutrons was measured by the large liquid scintillator technique. There was found a linear dependence between these two components of the energy liberated in fission. (FR)

5062 (CONF-731229-P16A, pp 101-122) MULTI-NUCLEON TRANSFER REACTIONS WITH HEAVY IONS. Nadkarni, D. M. (Bhabha Atomic Research Centre, Trombay, India). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27–31, 1973. Volume 16A.

Nuclear reactions between complex nuclei involving transfer of nucleons between them have been of considerable interest in recent years with the availability of beams of heavy ions accelerated to high energies. Here some of the features encountered in heavy-ion reactions, some recent data on the cross section for nucleon-transfer reactions, and the angular distribution of their products are briefly surveyed. The role of kinematics in these reactions and a semi-classical interpretation of the data is outlined. Finally, some recent results obtained in reactions induced by very heavy ions (Ar, Kr, Xe) and some of the problems encountered in the interpretation of these data are discussed. (12 figures; 2 tables) (auth)

5063 (GSI-tr-1/75) THE SEARCH FOR SUPERHEAVY ELEMENTS IN METEORITES. Popeko, A. G.; Ter-Akopyan, G. M.; Skobolev, G. K.; Goncharov, G. N. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (F. R. Germany)). Jan 1975. 13p. (In German). INIS.

6 figs.; 2 tabs.; 22 refs. Translated from the Russian report JINR-P-7-8042. Published in Yad. Fiz.

Measurements of neutron emission from the Saratov, Efremovka and Allende meteorites have been performed using neutron multiplicity detectors. An activity exceeding the background due to the spontaneous fission of uranium has been recorded. The possible relationship of the activity observed to both spontaneous fission of superheavy elements and anomalies in the content of heavy Xe isotopes in meteorites is discussed. (auth)

5064 (JEN-293) STUDY OF THE ENERGY LEVELS OF ^{231}Th BY ALPHA DECAY OF ^{235}U. Vano Carruana, E. (Junta de Energia Nuclear, Madrid (Spain)). 1974. 138p. (In Spanish). Dep. NTIS (US Sales Only) $10.25.

An alpha spectrum is obtained of a thin sample of ^{235}U with a 0.0013% content of ^{234}U. A total of eight lines are determined. Direct gamma spectra for low energy (X_L rays), medium energy (using continuous purification in a resin column of ionic exchange) and high energies, have permitted the identification of 51 ^{231}Th gamma rays. A gamma-gamma coincidences experiment permitted the establishment of the primary scheme of levels. Some of the suppositions have been verified in experiments of alpha-gamma coincidences and gamma-X_L rays coincidences. Eighteen energy levels are so established; sixteen of them have been identified like terms of the rotational bands; $5/2$ (633), the fundamental; $7/2$ (743), the favored; $5/2$ (752), the coupled to this one; $3/2$ (631) and $1/2$ (631) using some arguments of preceding nuclear reactions work. (auth)

5065 (ORNL-TM-4885, pp 12-14) PRECISE MEASUREMENTS AND CALCULATIONS OF ^{238}U NEUTRON TRANSMISSIONS. Olsen; de Saussure, G.; Silver, E. G.; Perez, R. B. Apr 1975.

In report to the U. S. Nuclear Data Committee.

5066 (UCRL-Trans-10813) MEASUREMENTS OF NEUTRON SPECTRA FROM THICK LEAD AND URANIUM TARGETS USING A SINGLE-CRYSTAL SPECTROMETER. Narziev, Kh.; Matusevich, E. S.; Daruga, V. K. Translated from Dokl. Akad. Nauk Tadzh. SSR; 16: No. 6, 28-31(1973). 6p. Dep. NTIS $4.00.

The energy distribution of neutrons from thick Pb and U targets bombarded by 22.7-MeV protons was measured in a wide energy range from 0.7 to 10 MeV. The absolute and integral yields of neutrons are tabulated and show that the high yield of neutrons from the U target is connected with a new mechanism for the production of fission neutrons. (3 figures, 2 tables) (auth)

5067 (WANL-TME-1121) CROSS SECTION STATUS REPORT. Melnick, M.; Gibson, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1965. 21p. Dep. NTIS $4.25.

A new set of cross sections for the n + ^{235}U reactions has been compiled. Among the changes from previous libraries used at WANL is the inclusion of resonances in the experimentaliy unresolved energy range (47.9 eV – 31.8 × 10^3 eV). A GAM Program is used to handle the resonance structure in this region. Smooth absorption cross sections due to negative energy resonance is

also added. It is pointed out that there exists a need at WANL for a program that will calculate cross sections for any target nuclei temperature given the resonance parameters for a zero temperature target. Comparisons may then be made with experimental results, leading to a cross section library with resonance parameters and smooth cross sections chosen to give agreement with experimental data. The X0 program for calculating cross sections for zero temperature target and EXT for calculating Maxwellian Doppler broadened Breit–Wigner resonances are discussed, and preliminary calculations are illustrated. Other cross sections added or changed are discussed. (6 figures) (SDF)

5068 ORELA MEASUREMENTS OF THE ^{235}U(n,f) CROSS-SECTION TO 100 keV. Peelle, R. W. (Oak Ridge National Lab., TN). pp 165-173 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Two sets of measurements of the ^{235}U(n,f) cross section made with ORELA in the energy range below 100 keV are compared. In both measurements, fission was detected by coincidence between pulses from a multi-plate fission chamber and a two segment boron-loaded scintillator tank. Neutron flux was measured using a beryllium-walled parallel-plate pulse ion chamber containing $^{10}BF_3$. The response of the ion chamber was assumed to be proportional to the shape of the ^{10}B(n,α) cross-section, for which the shape given by Sowerby et al. was assumed. In the experiment of Gwin et al., ORELA was operated at sufficiently low pulse frequency so that measurements could extend through the thermal energy range. They were normalized to the value 83.74 b·eV over the energy interval 0.02 to 0.4 eV. The data of Perez et al. were obtained at higher accelerator pulse frequency and are normalized over the energy range 100-200 eV where several recent measurements are in agreement. Preliminary data from both ORELA experiments are compared with other measurements. (3 figures, 1 table) (auth)

5069 DISCREPANCIES OBSERVED IN FISSION CROSS-SECTION MEASUREMENTS USING FISSION FOILS FROM DIFFERENT ORIGINS. Szabo, I.; Leroy, J. L.; Marquette, J. P. (CEN de Cadarache, France). pp 175-187 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

During the past few years, the fission cross sections of ^{235}U and ^{239}Pu have been measured below 1 MeV using a Van de Graaff accelerator and time-of-flight techniques. Measurements obtained with three fission chambers have been intercompared. One fission chamber containing a ^{235}U foil was constructed, calibrated and used previously by P. H. White. Two other thin-walled chambers, identical to each other, were equipped with ^{235}U and ^{239}Pu foils, respectively, prepared and assayed by the Central Bureau for Nuclear Measurements (CBNM). The count rates of the three chambers in a thermal neutron beam were also intercompared at CBNM. Since the cross section data obtained using the thin-walled ^{235}U chamber were systematically low while ratio data were systematically high, a detailed examination of sources of the systematic error was begun. Loss of material from the ^{235}U foil prepared by CBNM has been confirmed by both 2π and high-geometry alpha counting but the times at which losses have occurred have not yet been established. The data for the ^{235}U fission cross section based on the White chamber and reported at the Argonne Symposium in 1970 remain unchanged. The data for the same cross section reported at the Knoxville Conference in 1971 must be corrected because of the loss of material from the CBNM foil and because of a new value for the half-life of ^{234}U. (6 figures, 3 tables) (auth)

5070 MEASUREMENTS OF THE ^{235}U FISSION CROSS-SECTION IN THE FAST NEUTRON ENERGY RANGE. Poenitz, W. P. (Argonne National Lab., IL). pp 189-199 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The fission cross-section of ^{235}U was measured in the energy range from 35 to 3500 keV. The shape of the cross section was measured using the Grey Neutron Detector with different moderators. The shape curve was normalized with three absolutely measured values, one using the associated-activity method, the second using the neutron flux integration technique, and the third using the Black Neutron Detector for absolute neutron flux counting. The present results are subject to final fail assay and will be supplemented by additional measurements. (7 figures) (auth)

5071 MEASUREMENT OF THE ^{235}U FISSION CROSS-SECTION IN THE ENERGY RANGE 1 keV TO 1 MeV. Gayther, D. B.; Boyce, D. A.; Brisland, J. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 201-211 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Measurements of the fission cross section of ^{235}U using a 45-MeV linac and time-of-flight techniques have been extended into the energy region where most measurements have been made with Van de Graaff accelerators. The reported relative measurements cover the range 1 keV to 1 MeV. Fission events were detected by observing the fission neutrons with proton recoil detectors using pulse-shape discrimination against gamma rays. Most measurements were made with two detectors at 45° and two at 90°. The incident neutron spectrum was measured with a calibrated boron-vaseline plug detector. Background was determined by the "black" resonance filter technique. Corrections were applied for self-shielding, multiple scattering and changes of fission neutron detection efficiency resulting from changes with incident energy in the temperature and angular distribution of the fission neutron spectrum. The measured relative cross section has been normalized to an average value of 2.349 b in the 10- to 30-keV energy interval in agreement with the evaluation of Sowerby et al. The normalized data agree well with the Sowerby evaluation except below 3 keV and in particular confirm the shape of the cross section in the 30- to 100-keV range as reported by Sowerby, in contrast with other recent evaluations. The estimated error of the relative cross section is less than 4%. (1 fig., 2 tables) (auth)

5072 MEASUREMENT OF THE NEUTRON FISSION CROSS-SECTION OF ^{235}U BETWEEN 0.5 AND 1.2 MeV. Kaeppeler, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 213-226 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Because of the importance of the ^{235}U fission cross section as a secondary standard, an absolute measurement was performed in the neutron energy range between 0.5 and 1.2 MeV. The method adopted was based on the hydrogen (n,p) cross section. Monoenergetic neutrons from a fast pulsed source provided background discrimination by the time-of-flight method. A variety of runs was made to check the accuracy of sample masses and detector efficiencies. The consistency of the results confirmed that the experimental uncertainties of the seven absolute values lay between 2.6% and 3.4%. In addition, 12 relative values with statistical uncertainties of less than 2% were determined in order to establish the cross section shape. (6 figures, 4 tables) (auth)

5073 PROGRESS REPORT ON LASL MEASUREMENT OF THE ^{235}U FISSION CROSS-SECTION FROM 1 TO 6 MeV. Diven, B. C. (Los Alamos Scientific Lab., NM). pp 227-234 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Measurements of the ^{235}U fission cross section in the range 1 to 6 MeV, using a pulsed Van de Graaff accelerator, 2π fission counting and a proton recoil telescope to measure the neutron flux, are in progress. The product of the amount of ^{235}U on the fission foil and the efficiency of the 2π fission counting system was determined in a separate experiment by comparison with the fission rate of a standard ^{235}U foil counted in low geometry in a uniform thermal neutron flux. Corrections to the data and sources of error are described. Preliminary data contingent upon final mass determination of the standard ^{235}U foils are given. (1 table, 1 figure) (auth)

5074 VALUE OF ν BAR FOR ^{252}Cf. Axton, E. J. (National Physical Lab., Teddington, Eng.). pp 261-275 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

A number of absolute measurements of ν-bar for ^{252}Cf have been reported with reputedly high accuracy. At the time of the IAEA review in 1969, the results appeared to divide into two distinct groups at about 3.7 and 3.8 neutrons/fission. In the intervening period, some new measurements have appeared and the older measurements have been subjected to an objective scrutiny in an attempt to find an explanation for the discrepancy. A brief description of each experiment is given and in some cases suggestions are made for revising the value and/or the estimated uncertainty. The measurements now appear to form a consistent set with a weighted mean of 3.733 ± 0.008 neutrons/fission. (4 tables) (auth)

5075 SUMMARY OF THE ABSOLUTE MEASUREMENTS OF ν BAR FOR THE SPONTANEOUS FISSION OF ^{252}Cf. Conde, H. (Research Inst. of National Defence, Stockholm). pp 277-285 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The experimental techniques used in recent absolute measurements of the average number of fission neutrons, ν-bar, for spontaneous fission of ^{252}Cf are reviewed. The status of each experiment is discussed in relation to recent corrections and experimental effects currently being investigated. Results are summarized in tables. (3 tables) (auth)

5076 PROMPT NEUTRON YIELD FROM THE SPONTANEOUS FISSION OF ^{252}Cf. Boldeman, J. W. (Australian Atomic Energy Commission, Lucas Heights). pp 291-312 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The average number of prompt neutrons emitted per fission in the spontaneous fission of ^{252}Cf has been measured using the liquid scintillator method. A value of 3.735 ± 0.014 has been obtained. The results seem to resolve a discrepancy between values obtained previously by the liquid scintillator method and those obtained by other methods. (5 figures, 5 tables) (SDF)

5077 SUMMARY OF THE CONSULTANTS' MEETING ON THE 2200-m/s FISSION AND CAPTURE CROSS-SECTIONS OF THE COMMON FISSILE NUCLIDES. Deruytter, A. J. (EURATOM, Geel, Belgium). pp 315-318 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

In 1969, IAEA consultants reviewed the 2200-m/s fission parameters of the common fissile nuclei and recommended values on the basis of least-squares fits of the available data. In November 1972, another group of consultants met at the IAEA to review the input data and the assigned errors which determine the weighting of the various data in least-squares fitting procedure. New recommended values of the 2200-m/s fission parameters of ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu and ^{252}Cf will be published. (auth)

5078 USE OF CALIFORNIUM-252 AS A STANDARD FOR ν BAR AND NEUTRON SPECTRUM MEASUREMENTS. Kuz'minov, B. D. (Physical-Energy Inst., Obninsk, USSR). pp 321-325 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974). (In Russian).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The use of spontaneous californium 252 fission events as a standard for the calibration of neutron detectors in large-scale studies is considered and the difficulties of using californium in measurements of ν-bar are pointed out. Measurements of the neutron spectrum in spontaneous californium 252 fission require the collection of data in order to derive a recommended spectrum form which could be used as a standard in fast neutron spectroscopy. The detectors used in the studies are described. (1 table, 1 figure) (auth)

5079 EXPERIMENTAL STUDY OF THE PROMPT FISSION NEUTRON SPECTRUM INDUCED BY 0.5-MeV INCIDENT NEUTRONS ON ^{235}U. Johansson, P. I.; Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 327-332 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The spectrum of fission neutrons in the energy range 0.6 MeV to 15 MeV from fission of ^{235}U induced by 0.53-MeV neutrons has been measured by time-of-flight techniques with a large liquid scintillator. The relative flux of incident neutrons produced by the ^{7}Li(p,n)^{7}Be reaction was monitored with a direction-sensitive long counter. The energy scale of the time-of-flight spectrometer was calibrated over the range 0.5 MeV to 21 MeV by observing neutron groups from common source reactions and by neutron scattering from carbon. The relative efficiency of the liquid scintillator was determined in the range 0.9 MeV to 15 MeV by measuring n-p scattering, and below 0.9 MeV with the T(p,n)^{3}He reaction. Pulse-shape discrimination was used to eliminate gamma background. Corrections were applied for flux attenuation and for neutrons scattered from the uranium sample. The Watt form of the fission spectrum fits the experimental data reasonably well over the entire energy range covered, whereas the Maxwellian form does not. (3 figures) (auth)

5080 STANDARD FISSION NEUTRON SPECTRA. Ferguson, A. T. G. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 333-338 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

The advantages to be derived from the availability of a standard fission neutron spectrum are reviewed. The most appropriate choice of standard is considered and its status reviewed. It is concluded that the fission neutron spectrum from low energy neutron-induced fission of ^{235}U and that from spontaneous fission of ^{252}Cf would both be valuable as standards. In the case of ^{252}Cf it is not yet possible to give a satisfactory evaluation. The situation for ^{235}U is much more satisfactory and this body of data is ready for re-evaluation. (auth)

5081 CONNECTIONS BETWEEN AND COMMON PROBLEMS FOR LOW-ENERGY (eV REGION) AND HIGH-ENERGY (keV TO MeV REGION) PRECISION MEASUREMENTS. Deruytter, A. J. (EURATOM, Geel, Belgium). pp 341-348 of Neutron Standard Reference Data. Vienna; International Atomic Energy Agency (Dec 1974).

From 2nd IAEA panel on neutron standards reference data; Vienna, Austria (20 Nov 1972). See STI/PUB-371; CONF-721127-.

Experience from low-energy precision measurements should be helpful when moving to higher energy: (1) The definition of the samples (number of atoms, isotopic composition, chemical purity, weight, choice of preparation technique, etc.) should be carefully considered. (2) Measurements should be performed on several samples to permit cross-checks, possibly with other laboratories. (3) Where possible, overlapping energy regions between different machines and (or) detection techniques should be available to take advantage of the 2200-m/s reference values. (4) Analogous detection problems exist in low-energy and higher-energy experiments, e.g. 2π-geometry fission fragment counting. Problems connected with these measurements can sometimes better be studied at low neutron energy because of the available high-intensity neutron beams. (2 tables) (auth)

5082 NUCLEAR FISSION. Specht, H.J. (Physikalisches Institut der Universität Heidelberg, Heidelberg, Germany). Rev. Mod. Phys. 46: No. 4, 773-787 (Oct 1974).

The experimental evidence supporting the double–humped character of the fission barrier in actinide nuclei is reviewed and compared to theoretical predictions. The discussion covers the existence and half–life systematics of spontaneously fissioning isomers, shape–isomeric gamma decay, rotational transitions and the moment of inertia of isomers, fragment angular distributions in isomeric fission, intermediate structure in fission cross sections, and finally the systematics of barrier heights as deduced from fission probability measurements. The implications of a possible octupole deformation at the second barrier for fragment mass distributions are also discussed, including the size of the mass asymmetry and recent experiments on the competition between symmetric and asymmetric fission as a function of excitation energy. (auth)

5083 MEASUREMENT AND INTERPRETATION OF Γ_n/Γ_f FOR ACTINIDE NUCLEI. Gavron, A.; Britt, H.C.; Konecny, E.; Weber, J.; Wilhelmy, J.B. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. Lett. 34: No. 13, 827-830 (31 Mar 1975).

The (^{3}He,df) and (^{3}He,tf) reactions were used to measure fission probabilities from threshold up to ~ 12 MeV of excitation energy for a series of actinide nuclei. The data were fitted over the whole range of nuclei and excitation energies with a microscopic model which does not contain an arbitrary normalization for Γ_n/Γ_f. The fits indicate that for most actinide nuclei fission proceeds through a first saddle point that is not axially symmetric. (auth)

5084 FRAGMENT KINETIC ENERGY DISTRIBUTION IN THE FISSION OF ^{237}Np BY REACTOR NEUTRONS. Dange, S.P.; Ramaswami, A.; Manohar, S.B.; Prakash, S.; Ramaniah, M.V. (Radiochemistry Division, Bhabha Atomic Research Centre, Trombay, Bombay 400 085, India). Phys. Rev. C 11: No. 4, 1251-1257 (Apr 1975).

Recoil ranges of 10 fission products in aluminium from the reactor neutron fission of ^{237}Np were determined using radiochemical and γ-ray spectrometric methods. The recoil ranges were converted into kinetic energies of the fission fragments using different range-energy relations after applying necessary corrections for neutron evaporation. From the kinetic energy distribution, the kinetic energy deficit and averge total kinetic energy released were obtained. Using the experimental kinetic energy data of a number of fissioning systems, the deformations of fission fragments for a given mass number were calculated to examine their dependence on the mass and charge of the fissioning nucleus. It was observed that, for the asymmetric mass divisions, the fragment deformation does not change appreciably with the fissionability parameter, while, in the case of the symmetric mass division, the

deformation increases with the increase in the fissionability parameter. This difference is attributed to the influence of shells on the deformability of fission fragments. (auth)

5085 FRAGMENTS FROM URANIUM IRRADIATED BY 2.1 GeV/NUCLEON DEUTERONS AND ALPHA PARTICLES. Zebelman, A.M.; Poskanzer, A.M.; Bowman, J.D.; Sextro, R.G.; Viola, V.E. Jr. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 11: No. 4, 1280-1286 (Apr 1975).

Energy spectra at 90° in the laboratory were obtained for He, Li, Be, and B fragments from a uranium target irradiated with 4.9 GeV protons and 2.1 GeV/nucleon deuterons and α particles. Data at 25 and 155° were also obtained with the proton and α particle beams. In comparing the incident deuteron data with the incident proton data, it was found that the cross sections were a factor of 1.5 higher but the shapes of the energy spectra were unchanged. However, with incident α particles it was found that the cross sections were a factor of 3 to 4 larger, and the energy spectra were somewhat broadened, indicating that the effective Coulomb barriers are 15% lower, and the apparent temperatures, 1.5 MeV higher. It is concluded that in the α particle irradiations the deposition energies are larger than with either incident protons or incident deuterons. (auth)

5086 FRAGMENT NUCLEAR-CHARGE STRUCTURE IN THE THERMAL-NEUTRON-INDUCED FISSION OF ^{235}U. Muga, L.; Clem, A. (Chemistry Department, University of Florida, Gainesville, Florida 32611). Phys. Rev. C 11: No. 4, 1287-1291 (Apr 1975).

Using a thin film detector to indicate nuclear charge Z from measured specific luminescence values, direct evidence was obtained for fragment nuclear charge structure in the thermal-neutron-induced fission of ^{235}U. The structure, occurring as a preference for formation of alternate Z charge units, is most pronounced for fission events leading to higher total kinetic energy release. (auth)

5087 SEARCH FOR SUPERHEAVY ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 459-481 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The search for long-lived superheavy elements in natural samples including meteorites is reviewed first. The search involved detecting rare events of spontaneous fission. It was felt that the data obtained from the investigation of carbonaceous chondrites should be regarded as evidence supporting the possible existence of long-lived superheavy elements in the solar system. Another method involved the study of the heavy component of primary cosmic radiation; no evidence for the presence of superheavy nuclei was seen here, however. Experiments relating to the synthesis of superheavy elements in complete fusion reactions between heavy nuclei are recounted. Isotopes of fermium were produced; in addition, bombardment of Pb with ^{50}Ti and ^{54}Cr yielded products attributed to ^{255}104, ^{256}104 and an isotope of element 106 with cross sections of about 3×10^{-33} cm^2. Finally, experiments on the synthesis of superheavy elements by use of a Xe ion beam are detailed. The results were interpreted as observation of spontaneous fission of one of the isotopes of superheavy elements or a daughter formed after a chain of alpha decays. (13 figures, 2 tables) (RWR)

5088 TOTAL CROSS SECTION FOR THE ABSORPTION OF γ QUANTA BY Th^{232}, U^{235}, U^{238}, AND Pu^{239} IN THE REGION OF DIPOLE GIANT RESONANCE. Gurevich, G.M.; Lazareva, L.E.; Mazur, V.M.; Solodukhov, G.V. (Institute of Nuclear Research, USSR Academy of Sciences). JETP Lett. 20: No. 11, 343-344 (5 Dec 1974).

We consider the evolution of the form of the photodisintegration cross sections of the nuclei Th^{232}, U^{235}, U^{238}, and Pu^{239}, measured by the absorption method, as Z varies from 90 to 94. The observed change in the form of the cross section is connected with the properties of the nuclear surface. (auth)

5089 MASS ASYMMETRIC FISSION AND THE TERMINATION OF THE ASTROPHYSICAL R-PROCESS. Bengtsson, R. (Tekniska Hoegskolan, Lund (Sweden). Institutionen foer Matematisk Fysik); Howard, W. M. (Illinois Univ., Urbana (USA)). Phys. Lett., B; 55: No. 3, 281-285 (17 Feb 1975).

A recent calculation of the mass-asymmetric fission barriers for heavy neutron-rich nuclei is used to estimate the heavy to light mass fragment ratio (M_H/M_L) resulting from fission at the termination of the astrophysical r-process. The fragments due to mass-asymmetric fission at the termination of the r-process may account for the solar system abundance distribution of neutron-rich nuclei in the mass region $150 \lesssim A \lesssim 170$. (auth)

5090 LEVELS OF ^{233}Pa EXCITED IN HELIUM-INDUCED SINGLE-PROTON TRANSFER REACTIONS. Elze, T. W. (Frankfurt Univ. (F. R. Germany). Inst. fuer Kernphysik); Huizenga, J. R. (Rochester Univ., N. Y. (USA). Nuclear Structure Research Lab.; Rochester Univ., N. Y. (USA). Dept. of Chemistry). Z. Phys., A.; 272: No. 1, 119-125(1975).

The ^{232}Th(^{3}He, d)^{233}Pa and ^{232}Th(α, t)^{233}Pa reactions were studied with 28.5-MeV ^{3}He and 30-MeV α-particles. The reaction results are interpreted in terms of a distorted-wave Born-approximation analysis. Transferred angular momenta are deduced from (α,t) and (^{3}He,d) cross-section ratios, $R = d\sigma(\alpha,t)/d\sigma(^3He,d)$. Theoretical cross-sections, calculated in the framework of the Nilsson model with pairing and Coriolis interactions included, are in reasonable agreement with experiment. Rotational bands built on the following Nilsson proton configurations are identified in ^{233}Pa: $1/2^-$[530UP], $3/2^+$[651UP], $1/2^+$[660UP], $5/2^+$[642UP], $5/2^-$[523DOWN], and $3/2^-$[521UP]. (auth)

5091 STUDY OF NON-SLOWED DOWN FISSION PRODUCT IONS WITH A MASS SPECTROMETER. Siegert, G. Munich; Technische Univ. (1974). 84p. (In German). INIS.

Thesis.

Nonslowed-down products of the neutron-induced fission of uranium 235 were separated with the mass spectrometer at the FRM according to their masses and energies, and their interactions with matter, ion charges, electron capture cross-sections and scatterings were investigated. The intensity of the fission product beam could be increased by an order of about two. Nuclear spectroscopic measurements on short-lived fission products could thus also be carried out. In order to do this, each of the longer-living isobaric nuclei was removed from the measuring place by a belt conveyor transport system before it decayed. (GE)

5092 A NEW ON-LINE METHOD FOR DETERMINATION OF INDEPENDENT AND CUMULATIVE FISSION PRODUCTS. Steinwandter, H. (Technische Univ. Darmstadt (F. R. Germany)). Nucl. Instrum. Methods; 124: No. 2, 615-616(1 Mar 1975). (In German).

Independent and cumulative yields were determined in the gaseous phase on-line. The experimental evaluated independent and cumulative yields of ^{139}Xe and ^{139}I agree with theoretically calculated yields. (auth)

5093 AN INVESTIGATION OF THE PROPERTIES OF SINGLE-PARTICLE STATES IN THE SECOND MINIMUM OF ^{237}Pu. Hamamoto, I.; Ogle, W. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Nucl. Phys., A; 240: No. 1, 54-76(10 Mar 1975).

In connection with the recent measurement of the magnetic moments of the fission isomeric states in ^{237}Pu, the following subjects are investigated: The spin alignment of the lowest-lying states in a potential minimum which are populated by (α, 2nγ) reactions, and the fragment angular distributions in fission from isomeric states; the single-particle level scheme in a very deformed Woods-Saxon potential; the spin polarizability as a function of the quadrupole deformation. (auth)

5094 GAMMA DECAY OF THE ^{238}U SHAPE ISOMER. Russo, P. A.; Pedersen, J.; Vandenbosch, R. (Washington Univ., Seattle (USA)). Nucl. Phys., A; 240: No. 1, 13-28(10 Mar 1975).

A search for a competing γ-decay branch of the spontaneously fissioning ^{238m}U isomer is reported. The 200 nsec ^{238}U shape isomer was produced by the (d, pn) reaction with a pulsed beam of 18-MeV deuterons incident on natural uranium targets. A γ-ray line at 2.514 MeV was observed which is attributed to the decay of the shape isomer to the 0.045 MeV 2^+ rotational state of ^{238}U. It has a half-life in agreement with that observed for the fission branch and is produced with a yield consistent with predictions of a more penetrable inner barrier. A second weaker line was observed at 1.879 MeV corresponding in energy to the transition from the shape isomer to the first excited 1^- state at 0.680 MeV in ^{238}U. The decay of this line is also consistent with the measured half-life of ^{238m}U. (auth)

5095 EXPERIMENTS ON THE PRODUCTION OF FERMIUM NEUTRON-DEFICIENT ISOTOPES AND NEW POSSIBILITIES OF SYNTHESIZING ELEMENTS WITH Z > 100. Oganessian, Yu. Ts.; Iljinov, A. S.; Demin, A. G.; Tretyakova, S. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Nucl. Phys., A; 239: No. 2, 353-364(24 Feb 1975).

Experimental and theoretical data on the production of the neutron-deficient isotopes ^{244}Fm and ^{246}Fm in the bombardment of lead and bismuth isotopes with ^{40}Ar and ^{37}Cl ions are presented. By using different lead isotopes, the cross sections for the (^{40}Ar, xn) reactions with x = 1, 2, 3 and 4 were measured. It is shown that when a target of the "magic" ^{208}Pb nucleus or its neighbors is bombarded with ions of mass ≥ 40, the compound nuclei formed appear to be weakly excited and to de-excite by emitting only 2 or 3 neutrons. New possibilities of synthesizing elements with atomic number Z > 100 being discussed in the framework of the experimental data obtained. (auth)

5096 INVESTIGATION OF DELAYED FISSION IN ^{236}U. Christiansen, J.; Hempel, G.; Ingwersen, H.; Klinger, W.; Schatz, G.; Witthuhn, W. (Erlangen-Nuernberg Univ., Erlangen (F. R. Germany). Physikalisches Inst.). Nucl. Phys., A; 239: No. 2, 253-259(24 Feb 1975).

The fission isomer of ^{236}U was produced by the reaction ^{235}U(d,p)^{236}U using pulsed beam techniques. The half-life of the fission isomer was determined to be $T_{\frac{1}{2}} = 116 \pm 7$ ns. An isomeric to prompt fission ratio $\sigma_i/\sigma_f = (1.24 \pm 0.06) \times 10^{-5}$ was obtained. The measurements were performed with parallel-plate avalanche detectors which proved to be a high efficiency low background system. (auth)

5097 CHARGE DISTRIBUTION AND AVERAGE MASSES IN THE SPONTANEOUS AND ISOMERIC FISSION OF ^{234}U, ^{236}U AND ^{240}Pu. Hooshyar, M. A. (Pahlavi Univ., Shiraz (Iran)); Malik, F. B. (Indiana Univ., Bloomington (USA). Dept. of Physics). Phys. Lett., B; 55: No. 2, 144-146(3 Feb 1975).

Percentage yields for various elements and their associated average masses in the spontaneous and isomeric fission of ^{234}U, ^{236}U and ^{240}Pu are calculated for the same set of parameters which account for the percentage yield of different masses, half-lives, and the kinetic energy spectra of their respective fragments. (auth)

Nuclear Theory

Refer also to abstracts 4203, 4263, 4474, 4660, 4663, 4673, 4747, 4826, 4969, 5266, and 5283.

5098 (CEA-N-1700, pp 262-263) STUDY OF A TWO SPHEROID SCISSION MODEL. Babinet, R. 1973. (In French).

In progress report of the Nuclear Physics Department, 1 October 1972-30 September 1973.

A scission model of two spheroidal liquid drops has been used to calculate for each fragment pair the potential energy surface as a function of fragment deformation parameters. (auth)

5099 (CNEN-LNF-74-47(P)) TENSOR POTENTIAL AND ENERGY GAP IN NUCLEAR MATTER. Palumbo, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 7 Aug 1974. 14p. INIS.

It is shown that the most important contribution to the energy gap of nuclear matter comes from the tensor potential. When this is taken into account and the exact gap equations are solved (rather than their BCS approximations), the energy gap is found to be of the order of 1 MeV at normal density, corresponding to $k_F = 1.4$ fm^{-1}. (INIS)

5100 (CONF-731229-P16A, pp 1-12) PHASE TRANSITIONS IN ATOMIC NUCLEI. Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27-31, 1973. Volume 16A.

The types of changes in nuclei which have been regarded as phase transitions involve sudden changes in the shape of a nucleus as a function of excitation energy (e.g., ^{16}O and the fission isomers), sharp changes in the shapes of nuclei as a function of the number of nucleons (spherical-prolate and prolate-oblate transitions in rare earth nuclei), and sudden changes in the nature of collective motion as a function of excitation energy and as a function of the number of nucleons (the superfluid-normal phase transition occurring in deformed nuclei with rotational spectra. Examples of nuclei in which such transitions take place are given, and some possible new observational effects are noted. (7 figures) (RWR)

5101 (CONF-731229-P16A, pp 77-86) REACTION MECHANISM OF TRANSFER REACTIONS. Mukherjee, S. (Saha Inst. of Nuclear Physics, Calcutta). 1973.

From proceedings of the nuclear physics and solid state physics symposium; Bangalore, India (27 Dec 1973).

In proceedings of the nuclear physics and solid state physics symposium, Bangalore, December 27-31, 1973. Volume 16A.

The reaction mechanism of transfer reactions as it has been elucidated by recent theoretical and experimental investigations is reviewed. The following aspects of the direct reaction mechanism are treated: angular momentum mismatch, DWBA without cut-off, spin dependences, transfer reactions with heavy ions, and compound-nucleus effects on the direct mechanism. (3 figures) (RWR)

5102 (CONF-750303-52) BENCHMARK EXPERIMENTS FOR NUCLEAR DATA. Bohn, E. M.; Maerker, R. E.; McCrosson, F. J.; LaBauve, R. J.; Magurno, B. A.; Schenter, R. E. (Argonne National Lab., Ill. (USA)). 3 Mar 1975. Contract W-31-109-Eng-38. 9p. Dep. NTIS $4.00.

From proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

Benchmark experiments offer the most direct method for validation of nuclear data. Benchmark experiments for several areas of application of nuclear data were specified by CSEWG. These experiments are surveyed and tests of recent versions of ENDF/B are presented. (auth)

5103 (ITF-74-161P) SOME GROUP-THEORETICAL ASPECTS OF THE GENERALIZED HYPERSPHERICAL FUNCTION METHOD. Asherova, R. M.; Knyr, V. A.; Smirnov, Yu. F.; Tolstoi, V. N. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 22p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

The connection of the generalized hyperspheric function method with the translationally invariant shell model, Elliott's SU(3) scheme and generator coordinate method is discussed. It is shown that the calculations in the main approximation of the generalized hyperspherical function method are equivalent to the diagonalization of the Hamiltonian matrix of nucleus in the irreducible representation space of the noncompact group Sp(6,R) of the canonical transformations. The wave function of this method may be represented also in the Hill-Wheeler integral form. In this integral the generator function coincides with the projected Hartree-Fock wave function. The interrelations of different nuclear models discussed above allow one to compare these models and to clear the general feature of results which may be obtained in the generalized hyperspherical function method. (auth)

5104 (JINR-D3-7991, pp 96-99) REACTION ^{7}Be(n,2α) AS AN OBJECT FOR THE STUDY OF NON-CONSERVED PARITY OF NUCLEAR FORCES. Andreev, V. N. (Inst. of Theoretical and Experimental Physics, Moscow). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The experimental difficulties and favorable factors in the detection of the ^{7}Be(n,2α) reaction are outlined. Two experimental methods for detecting the reaction and determining the nonconservation of parity of nuclear forces in the reaction are suggested. (1 figure) (JSR)

5105 (JINR-D3-7991, pp 233-265) NEW APPROACH TO THE STUDY OF HIGHLY EXCITED STATES. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1974. (In Russian).

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The individual terms of the Hamiltonian used in the semimicroscopic description of high-energy states are examined and analyzed to determine which of them exist at intermediate and high excitation energies. The process of fragmentation in the production of high-energy states is examined, and a model for a description of the fragmentation of odd deformed nuclei is given. As a satisfactorily accurate description of the density of highly excited states is one of the criteria of the range of applicability of this model, the fragmentation model is analyzed on this basis. A general semimicroscopic description of excited states based on the operator form of the wave function is examined. The structure of highly excited states and compound states is discussed in conclusion. (5 figures, 2 tables) (JSR)

5106 (JINR-D3-7991, pp 266-293) SOME ASPECTS OF NEUTRON RESONANCE RESEARCH. Coceva, C. (CNEN, Bologna). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The first part of the paper is devoted to correlations of level energies. A general introduction is given, and the problem of statistics is discussed, in particular, the work of Dyson and Mehta. Experimental evidence in favor of the Dyson-Mehta theory, supporting both long-range and short-range correlations, is summarized. The second part of the paper concerns the spin dependence of average resonance quantities. Level densities are treated, and two methods for the determination of the value of the spin cut-off parameter from neutron resonance measurements are examined. Although conflicting results on the spin dependence of neutron strength functions have been obtained, there is at present no convincing evidence for a spin dependence in the s-wave strength function. A method for measuring the ratio of the capture rates in the two spin states as a function of neutron energy is described. (8 figures, 2 tables) (RWR)

5107 (JINR-D3-7991, pp 317-357) PRE-EQUILIBRIUM MODELS FOR NUCLEAR REACTIONS AND STUDIES INVOLVING NEUTRONS. Kalbach, C. (CEN, Saclay, France). 1974.

From 2nd international school on neutron physics; Alushta, USSR (2 Apr 1974).

In II international school on neutron physics.

The kinds of processes which the preequilibrium models try to explain are described, and the basic philosophies behind the cascade model, the Fermi-gas-equilibration model, the Griffin or exciton model, and the hybrid model are briefly set forth. Then the Griffin model is discussed in some detail. Its description of the nuclear equilibration process, the empirical values for the model parameters as found from data analyses, and the utility of the model in describing data when systematic values for the parameters are chosen are considered. Finally, some of the unanswered questions with regard to this model are treated; these include the accuracy of the low-energy part of calculated preequilibrium spectra, the roles of the pairing and Coulomb forces in the initial stage of a reaction, and the importance of alpha clustering or quartet structures. The discussion is restricted to reactions with from 20 to 100 MeV excitation in the intermediate nucleus. (19 figures, 2 tables) (RWR)

5108 (JINR-P2-8528) FRAGMENTATION MECHANISM OF RELATIVISTIC HEAVY IONS. Luk'yanov, V. K.; Titov, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A model is suggested which explains the main regularities of the behavior of the fragmentation cross section of relativistic heavy ions including their relative yields. The analogy of this process with the corresponding reactions of nonrelativistic ions is shown. (auth)

5109 (JINR-P4-8433) MODEL DESCRIBING THE STRUCTURE OF HIGH-EXCITED STATES OF DEFORMED NUCLEI. The Case of Two Close Energy Poles. Akulinichev, S. V.; Malov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The model intended for investigation of the structure of high-excited states of deformed odd-mass nuclei is considered. The case is considered when two states are situated close to each other and it is necessary to take into account their interaction. (auth)

5110 (JINR-P4-8447) ONE-POLE APPROXIMATION IN THE MODEL DESCRIBING THE STRUCTURE OF DEFORMED NUCLEUS HIGHLY EXCITED STATES. Malov, L. A.; Ochirbat, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). Dep NTIS (US Sales Only) $4.00.

The equations, obtained in the framework of semimicroscopic approach for description of highly excited states of odd-mass deformed nuclei, are solved taking into account the corrections to the one-pole approximation. (auth)

5111 (JINR-P4-8474) NUCLEAR POTENTIAL AND DENSITY RADII. Bal'butsev, E. B.; Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Some data outside the direct fitting procedure of the optical potential parameters are enumerated showing that the radius for the nuclear potential with diffuse surface is greater by about 0.6 fm than the radius in the distribution of nuclear matter. The difference in the volumes taken by the matter and by the potential is attributed to the decrease of the single-particle wave functions at the surface of the nucleus. (auth)

5112 (JINR-P4-8492) MANY-POLE APPROXIMATION IN A MODEL FOR DESCRIBING THE STRUCTURE OF HIGHLY EXCITED STATES IN DEFORMED NUCLEI. Malov, L. A.; Ochirbat, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An approximate method is proposed for the solution of the system of equations obtained by means of the semimicroscopic approach and describing the structure of highly excited states in deformed nuclei. This method is applicable when the energy and the structure of excited state are affected by a few close and strongly coupled configurations. (auth)

5113 (RLO-1388-258, pp 91-94) IMPORTANCE OF COULOMB INTERACTION POTENTIALS IN HEAVY ION DWBA CALCULATIONS. Cramer, J. G.; DeVries, R. M.; Satchler, G. R. Jun 1974.

In annual report, 1974.

5114 NUCLEAR SIZES AND THE OPTICAL MODEL. Jackson, D. F. (Univ. of Surrey, Guildford, Eng.). Rep. Progr. Phys.; 37: 55-146(1974).

The study of the nuclear scattering of strongly interacting elementary particles including nucleons, pions and anti-protons and of composite particles, and the interpretation of this scattering in terms of the optical model, is reviewed. The complications surrounding the interpretation of nuclear size information from scattering data are discussed and an indication is given of the areas of confidence and uncertainty in the determination of size parameters. The current state of knowledge on the nuclear matter distribution and particularly the neutron distribution, as obtained from theoretical approaches, coulomb energy differences and nuclear scattering is reviewed. (auth)

5115 NUCLEAR CHARGE DISTRIBUTIONS. Barrett, R. C. (Univ. of Surrey, Guildford, Eng.). Rep. Progr. Phys.; 37: 1-54(1974).

Different methods of obtaining information about nuclear charge distributions are reviewed and the nature of this information is discussed. The calculations involved in the analysis of electron scattering and electronic and muonic atom measurements are described with particular reference to the approximations made and the small corrections which must be taken into account. A number of calculations based on dynamical models of the nucleus are discussed and examples are given of the resulting densities. Results are given for selected nuclei and for certain groups of isotopes and isotones, and comparisons are made between phenomenological and theoretically derived densities. (auth)

5116 NUCLEAR ROTATIONAL BANDS GENERATED BY QUADRUPOLE OPERATORS. Joshi, V. Durham, NC; Duke Univ. (1974). 99p. University Microfilms Order No. 75-2390. Thesis (Ph. D.)

The suggestion made by Gell-Mann that the SL(3,R) group may be a useful symmetry in nuclear rotational bands is investigated. By using a phenomenological description of a deformed rotator, differential operators representing the time derivatives of quadrupole moments are constructed and the conditions under which they satisfy the SL(3,R) commutation relations examined. It is then found that there are three sets of unitary irreducible representations of SL(3,R) corresponding to three different classes of rigid rotators. The matrix-elements in each of these classes are evaluated and the results compared with those of the recent investigation by Weaver and Biedenharn. With the help of explicit differential operators representation of the generators of SL(3,R), the computation of the Casimir operators becomes a feasible task, and the invariants have been calculated. It is also shown that this procedure can easily be carried into the double covering group SL(3,R) to yield the half-integer spin bands resorting to a particle-core coupling model. The SL(3,R) and $T_5 \times SU(2)$ models for quantum rotators are compared and it is shown that most of the SL(3,R) representations can be obtained from the $T_5 \times SU(2)$ representations by means of a generalized Gell-Mann formula. (Diss. Abstr. Int., B)

5117 BRUECKNER-HARTREE-FOCK CALCULATIONS IN TWO NUCLEAR MODELS FOR CLOSED SHELL AND SUPERHEAVY (A EQUALS 298, Z EQUALS 114) NUCLEI USING EFFECTIVE K-MATRIX. Trivedi, H. P. Durham, NC; Duke Univ. (1974). 127p. University Microfilms Order No. 75-2434. Thesis (Ph. D.)

A method based on the Brueckner K-matrix formalism is presented for introducing a realistic effective single particle Hamiltonian in nuclear matter. A transition to finite nuclei is then made using a modified energy density functional method. Various finite nuclei corrections are then introduced, justified, and their effects discussed. Brueckner-Hartree-Fock calculations for several closed shell nuclei are performed and their binding energies, radii, density distributions and single particle spectra determined with two models. While both models are found to account for the properties of the nuclei under investigation satisfactorily, model II seems to give better results than model I in just about every respect. Model I is simpler and it is based on Meldner's work while model II is more complex and is derived from Bethe's arguments. Model II reproduces the observed level density near the Fermi surface in finite nuclei significantly better than model I and also all other self-consistent calculations to date. Calculations for the superheavy nucleus (A equals 298, Z equals 114) are also performed with both models and compared with predictions of other authors. Brueckner rearrangement energies and the resulting distinction between the self-consistent single particle energy and the removal (or separation) energy as well as the ambiguities in the definition of the latter are discussed. The method used for solving the resulting nonlocal density dependent Schroedinger equation is described in detail. (Diss. Abstr. Int., B)

5118 BOSON APPROXIMATION IN THE ONE-LEVEL MODEL. Medvedev, B. I. (Moscow Metalurgical Inst.). Yadern. Fiz.; 21: No. 2, 273-278(Feb 1975). (In Russian).

The interaction problem for fermions on the same level at low degree of the level filling is reduced to the interaction problem

for bosons with different momenta. The character of transition of the nucleus to the deformed state and the origin of the rotational spectrum is considered. (auth)

5119 MODEL OF PREEQUILIBRIUM DECAY OF EXCITED NUCLEI. Gudima, K. K.; Ososkov, G. A.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 21: No. 2, 260-272(Feb 1975). (In Russian).

Considering the establishing of the statistical equilibrium in an excited nucleus in terms of a random Markov process, a model of the nuclear decay from the preequilibrium state is proposed. The model generalizes the Griffin–Blann exciton model. The dynamics of the model is demonstrated. The calculation results are compared with the data. (auth)

5120 INTERMEDIATE CHANNELS IN PROCESSES OF INCOHERENT PRODUCTION OF PARTICLES ON NUCLEI. Gevorkyan, S. R.; Zhamkochyan, V. M.; Tarasov, A. V. (Erevan Physical Inst.). Yadern. Fiz.; 21: No. 2, 288-291(Feb 1975). (In Russian).

In framework of the multiple scattering theory the problem is considered of account of the intermediate channels in processes of incoherent production of particles on nuclei. Limiting cases of low ($\Delta l \gg 1$) and high ($\Delta l \ll 1$) energies are considered in detail. (auth)

5121 POLARIZATION NUCLEAR PHYSICS. Proceedings of a Meeting Held at Ebermannstadt, Germany, October 1–5, 1973. Fick, D. (ed.). Lectures Notes in Physics, Volume 30. New York; Springer-Verlag New York Inc. (1974). 300p. (CONF-7310105-). $9.90.

A collection of nine papers discussing various polarization phenomena in the context of theoretical and experimental nuclear physics is presented. (SDF)

For abstracts of individual papers see: 4979, and 5122–5129.

5122 THEORY OF POLARIZATION MEASUREMENTS. Observables, Amplitudes, and Symmetries. Simonius, M. (Eidg. Techn. Hochschule, Zurich). pp 38-87 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

A theoretical description of polarized beams and their measurement is discussed along with a formalism for scattering and reactions. Only two particle final states are treated explicitly. Decay angular distributions are analyzed with emphasis on their use as a convenient tool for measuring the polarization of excited or particle unstable states. Possibilities for the investigation of parity and time reversal invariance with the aid of polarization measurements are discussed. (SDF)

5123 NUCLEON–NUCLEON FORCE. McKee, J. S. C. (Univ. of Birmingham, Eng.). pp 88-113 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

Our present understanding of the nucleon-nucleon force is examined in an attempt to discover how realistic are the current descriptions of the two body interaction. The salient features of the nuclear force are reviewed and new information from the three body system is discussed. (SDF)

5124 HYPERFINE INTERACTION AND POLARIZATION. Matthias, E. (Freie Univ., Berlin). pp 114-160 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

The discussion deals with hyperfine interactions in oriented nuclear states and is restricted to dipole and quadrupole interactions. Three types of experiments are examined: (1) perturbed angular correlation techniques; (2) nuclear orientation produced by low temperature, polarized neutron capture, and optical pumping techniques; and (3) Moessbauer effect in oriented systems. Features of hyperfine interactions in free atoms and gases, liquids, and solids are illustrated. (SDF)

5125 RESONANCES, POLES, AND POLARIZATION. Plattner, G. R. (Univ., Basel). pp 162-183 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

A conceptual introduction to some aspects of resonance phenomena in nuclear reactions is presented. It is shown how an experimentalist can deduce S matrix pole positions and residues from his measurements, and how these parameters are related to nuclear structure. Remarks are generally limited to elastic scattering of spinless particles in the absence of inelastic processes. Examples of resonance phenomena in reactions between light nuclei at low energy are given. (SDF)

5126 ISOBARIC ANALOG RESONANCES. Graw, G. (Univ., Erlangen-Nuernberg, Erlangen, Ger.). pp 184-211 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

A few experiments, selected to illustrate the power of polarization experiments for investigating various aspects of isobaric analog resonances, are described. Basic properties of IAR's in heavy nuclei are briefly discussed. The extraction of spectroscopic information from elastic scattering, inelastic scattering, and inelastic scattering in coincidence with the subsequent gamma deexcitation is examined in some detail. Doorway state aspects of the IAR are studied from inelastic and elastic polarization experiments. (17 figures, 5 tables) (SDF)

5127 FINE STRUCTURE OF ISOBARIC ANALOG RESONANCES AND POLARIZATION. Harney, H. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 212-228 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

If the S matrix is split into direct and fluctuating parts, it is known that channel-channel correlations (CCC) exist if the direct term is not diagonal. A formalism based on Hauser-Feshbach theory is given that shows how to calculate CCC, and some new aspects are presented. Channel-channel correlations for isolated isobaric analogs are discussed with and without inclusion of absorption away from resonance. (SDF)

5128 DIRECT INTERACTION. Haeberli, W. (Univ. of Wisconsin, Madison). pp 229-267 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

The discussion is divided into two main parts: elastic scattering and the interpretation of the experiments in terms of the optical model, and nucleon transfer reactions with an emphasis on (d,p) stripping and (p,d) pickup reactions. Much of the survey concerns polarization phenomena, and descriptions of vector and tensor analyzing power are given. (29 figures, 63 references) (SDF)

5129 POLARIZATION PHENOMENA IN INELASTIC SCATTERING. Verhaar, B. J. (Technische Hogeschool, Eindhoven, Netherlands). pp 268-292 of Polarized Nuclear Physics. Fick, D. (ed.). New York; Springer-Verlag New York Inc. (1974).

From proceedings of a meeting on polarization nuclear physics; Ebermannstadt, F.R. Germany (1 Oct 1975). See CONF-7310105-.

An attempt is made to clarify the principles of inelastic scattering using the distorted wave Born approximation, concentrating on inelastic proton scattering. The principal aspects and merits of the microscopic description and the necessity of including the N-N spin orbit force are discussed. (7 figures) (SDF)

5130 RECOIL EFFECTS IN ALLOWED BETA DECAY: THE ELEMENTARY PARTICLE APPROACH. Holstein, B.R. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01002). Rev. Mod. Phys. 46: No. 4, 789-814 (Oct 1974).

Allowed beta decay is studied using the elementary particle approach including all second-forbidden terms. Model-independent forms are given for various spectrum and correlation effects with parent polarization and/or orientation and for delayed particle emission correlations. The restrictions due to various symmetry assumptions are analyzed, as well as the problem of Coulomb corrections. We comment on past and future experiments in this realm. (auth)

5131 RELATIVISTIC SECOND-ORDER ENERGY IN INFINITE FERMION MATTER. Bolsterli, M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. D 11: No. 2, 312-317 (15 Jan 1975).

The second-order terms in the energy per unit volume or energy per particle in infinite fermion matter are calculated for scalar, vector, and pseudoscalar meson exchanges. (auth)

5132 NUCLEAR REARRANGEMENT SCATTERING. II SCATTERING OF COMPOSITE PROJECTILES WITH APPLICATION TO DEUTERON ELASTIC SCATTERING, THE DEUTERON OPTICAL MODEL, AND DEUTERON STRIPPING. Scheerbaum, R.R. (Department of Physics, Texas A & M University, College Station, Texas 77843); Shakin, C.M. Ann. Phys. (N.Y.) 89: No. 2, 299-358 (Feb 1975).

Methods developed for the description of scattering from correlated nuclei and applied previously to the elastic scattering of nucleons, and

to quasifree (p,2p) reactions, are extended to include the possibility of describing composite nuclear projectiles. These methods are then applied to obtain a unified description of deuteron scattering. We consider the elastic and stripping final channels explicitly. The correlated structure of the deuteron and of the target nucleus and the influence of these correlations on the off-shell character of the appropriate channel interactions are taken fully into account. So too are the Pauli and exchange effects due to the identity of the nucleons of the deuteron and the target nucleus. Our methods, however, do not contain any treatment of target recoil effects. The theory leads to a two-potential formulation for the optical potential for deuteron elastic scattering. The first potential describes the deuteron breakup and scattering resulting from the Pauli principle as it applies to the constituents of the target, and is expressed entirely in terms of well-behaved quantities, even in the case of singular nucleon-nucleon interactions. The second potential contains the remaining deuteron-nucleus interaction and is evaluated in terms of a fully renormalized perturbation expansion. While this expansion involves the usual Brueckner reaction matrices and occupation probabilities for the bound orbitals, it cannot in general be expressed solely in terms of such quantities. It requires the introduction of more complicated two-body interaction matrices as well. These are quite distinct from the reaction matrix because they involve the entire two-body Hamiltonian and because protection operator accompanying the intermediate state propagator cannot be factorized into a product of one-body projection operators. At high energy, however, the latter interaction becomes negligible and, to lowest order, the deuteron optical potential reduces to the sum of two one-body optical potentials, as expected. The correct energy dependence of these potentials is explicitly exhibited. Deuteron stripping is also discussed in some detail within the context of our formalism. We obtain the lowest-order expression for the stripping amplitude and we indicate a certain class of corrections to this lowest-order term. The various approximations which are necessary to make contact with phenomenological distorted-wave treatments are indicated. (auth)

5133 A GENERATOR COORDINATE THEORY OF NUCLEAR REACTIONS. Giraud, B. (D.Ph-T, CEN-Saclay and MDIS, DITEIM, Paris, France); LeTourneux, J.; Osnes, E. Ann. Phys. (N.Y.) 89: No. 2, 359-392 (Feb 1975).

The generator coordinate formalism is generalized to incorporate optical potentials, coupled waves, and a distorted-wave approximation. An estimate of the importance of recoil is proposed. An analytical illustrative example related to the generator coordinate DWBA is given. (auth)

5134 LEVEL DENSITY FLUCTUATIONS AND RANDOM MATRIX THEORY. Bohigas, O.; Giannoni, M.J. (Institut de Physique Nucléaire, Division de Physique Théorique, 91406 Orsay, France). Ann. Phys. (N.Y.) 89: No. 2, 393-422 (Feb 1975).

The main purpose of this work is to elucidate whether there are significant differences in the local properties between two-body (TBRE) and orthogonal (OE) ensembles of random matrices. Emphasis is put on the validity of ergodic properties, and results obtained by numerical means are discussed from that point of view. Spectral and ensemble averaging procedures are compared. All the local properties studied show compatibility between TBRE and OE results, and no significant evidence of inconsistency of theoretical predictions and experimental data is found. (auth)

5135 SEPARABLE EXPANSION OF THE t MATRIX WITH ANALYTIC FORM FACTORS. Adhikari, S.K.; Sloan, I.H. (Department of Applied Mathematics, the University of New South Wales, Kensington, New South Wales, 2033, Australia). Phys. Rev. C 11: No. 4, 1133-1140 (Apr 1975).

A recently proposed separable expansion of the t matrix (assuming the potential to be given) is rederived from the Schwinger variational principle. Also, analytic expressions are given for the integrals in the separable expansion if the potential is a superposition of Yukawa potentials, and for suitable choices of the expansion functions. Calculations with two commonly used S-wave nucleon-nucleon potentials show that the expansion can converge significantly faster than the unitary pole expansion if the freedom in the choice of the expansion functions is exploited. (auth)

5136 EFFECT OF DEUTERON BREAKUP ON (d, p) CROSS SECTIONS. Rawitscher, G.H. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. C 11: No. 4, 1152-1158 (Apr 1975).

Deuteron-nucleus breakup wave functions, obtained in a previous study, are applied to calculate the contribution of breakup to zero-range stripping matrix elements for the case of 21.6-MeV deuterons incident on ^{40}Ca. The results are compared with the method of Johnson and Soper. The two calculations agree quite well, but the Johnson-Soper method slightly overestimates the effect of breakup for the surface partial waves, and it suppresses too much the stripping amplitudes for the interior partial waves. (auth)

5137 RELATION BETWEEN THE WATSON AND KERMAN-McMANUS-THALER MULTIPLE SCATTERING FORMALISMS. Nagarajan, M.A.; Wang, W.L. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Ernst, D.J.; Thaler, R.M. Phys. Rev. C 11: No. 4, 1167-1173 (Apr 1975).

The Watson and the Kerman-McManus-Thaler formulations of the multiple scattering problems are compared, and transformations between the one and the other are given. Some numerical studies of the effects of certain approximations are also presented. (auth)

5138 NUCLEUS-NUCLEUS REACTION CROSS SECTIONS AT HIGH ENERGIES: SOFT-SPHERES MODEL. Karol, P.J. (Chemistry Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). Phys. Rev. C 11: No. 4, 1203-1209 (Apr 1975).

A simple analytical expression is derived for the total nuclear reaction cross section in heavy-ion heavy-ion collisions at high energies based on the semiclassical optical model. Tapered nuclear density distributions are used in conjunction with nucleon-nucleon collision cross sections. (auth)

5139 GENERAL FORMALISM FOR PION PRODUCTION IN NUCLEI: APPLICATION TO $pd \to t\pi$. Fearing, H.W. (Nuclear Research Centre, Department of Physics, University of Alberta, Edmonton, Alberta, Canada). Phys. Rev. C 11: No. 4, 1210-1226 (Apr 1975).

Motivated by the recent interest in (p, π) reactions which leave the nucleus in a definite final state, we have obtained a general formalism for such reactions and applied it to the reaction $pd \to t\pi$, for which there is recent medium energy data. The approach is essentially impulse approximation based on the assumption, originally used by Ruderman, that the reaction mechanism is the same as in $pp \to d\pi$. It differs from previous such calculations in that we have included distortion effects and have derived and used an expression for the form factor which does not require the crude approximations for the wave functions used before. We apply this formula to $pd \to t\pi$ and obtain zero-parameter fits which are a significant improvement over previous calculations and which reproduce the shape and normalization of the data quite well at 470 and 590 MeV and qualitatively at 340 MeV, except that,as in other calculations, the backward peak at 470 MeV is not reproduced. Distortion effects are important but purely absorptive and serve, as do most other theoretical uncertainties, simply to adjust the normalization. (auth)

5140 DETERMINATION OF THE CRITICAL ANGULAR MOMENTUM FOR HEAVY-ION FUSION USING THE PROXIMITY POTENTIAL. Seglie, E.; Sperber, D. (Rensselaer Polytechnic Institute, Troy, New York 12181); Sherman, A. Phys. Rev. C 11: No. 4, 1227-1230 (Apr 1975).

The critical angular momentum for complete fusion is calculated using the classical dynamical theory. Ion-ion potentials as suggested by the Berkeley and Orsay groups are used. Reasonable agreement between the calculated and measured values of the critical angular momentum is obtained. (auth)

5141 CLASSICAL MODEL FOR STRONGLY DAMPED COLLISIONS IN HEAVY-ION REACTIONS. Bondorf, J.P. (The Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark); Huizenga, J.R.; Sobel, M.I.; Sperber, D. Phys. Rev. C 11: No. 4, 1265-1269 (Apr 1975).

A classical model with nuclear stretching under the influence of a repulsive conservative force and a dissipative radial force is proposed to explain the observed kinetic energy spectra and angular distributions of very heavy-ion reactions. The model is applied to the strongly damped collisions in the ^{209}Bi + ^{84}Kr reaction. (auth)

5142 CORE POLARIZATION IN INELASTIC SCATTERING AND EFFECTIVE CHARGES. Brown, V.R. (Lawrence Livermore Laboratory, Livermore, California 94550); Madsen, V.A. Phys. Rev. C 11: No. 4, 1298-1311 (Apr 1975).

A perturbation theory treatment is made of core-polarization effects in electromagnetic and inelastic scattering transitions due to high-lying collective excitations. Formulas are presented which make the connection between core-polarization parameters in inelastic scattering and effective charges from electromagnetic transitions. These relationships show that there is a natural disparity in neutron and proton polarizations, which arises from the departure (due to the neutron excess) of these high-lying collective excitations from pure isoscalar or isovector character. The resulting isospin-polarization matrix is calculated both from a schematic model and by making a connection with Bohr-Mottelson parametrization of isoscalar and isovector effective charges. The effects of spreading of the isoscalar giant resonance are taken into account in an approximate way which results in a formulation with one parameter free to be determined from empirical electromagnetic effective charges. Numerical results which show the effects of core polarization in electromagnetic transitions, (α, α'), (p,p'), and (π, π') are presented for ^{118}Sn and ^{207}Pb. (auth)

5143 ELECTRON SHAKEOFF ACCOMPANYING INTERNAL CONVERSION. Mukoyama, T.; Shimizu, S. (Institute for Chemical Research and Radioisotope Research Center, Kyoto University, Kyoto, Japan). Phys. Rev. C 11: No. 4, 1353-1363 (Apr 1975).

The electron shakeoff probabilities accompanying the internal conversion process have been calculated in the sudden approximation, using screened relativistic hydrogenic wave functions. The screening constants have been determined from the relativistic self-consistent-field calculations, and the presence of a vacancy resulting from internal conversion has been taken into account. The present results indicate that relativistic effects cause an appreciable increase in the probabilities. It is also shown that the prediction of Carlson *et al.* is a good approximation to the shakeoff probability accompanying internal conversion. The calculated results have been compared with available experimental data. There is fairly good agreement between the calculated and the recently measured values. The need for new data is emphasized. (auth)

5144 BOSON REPRESENTATION FOR THE QUANTIZED ROTATOR. Marshalek, E.R. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 11: No. 4, 1426-1431 (Apr 1975).

Boson expansions are given in closed form for the basis states and fundamental operators of the quantized rotator. The boson representation is especially useful for describing states of high spin. (auth)

5145 ACCURACY OF THE UNITARY POLE APPROXIMATION AT POSITIVE ENERGIES FOR LOCAL POTENTIALS CONTAINING A HARD CORE. Lagu, A.V.; Maheshwari, C.; Mathur, V.S. (Department of Physics, Banaras Hindu University, Varanasi-221005, India). Phys. Rev. C 11: No. 4, 1443-1447 (Apr 1975).

The accuracy of the unitary pole approximation (UPA) to the two-body t matrix at positive energies has been examined for the case of a local potential with a hard core. To this effect the S-wave phase shifts and the half-shell functions (Baranger, Giraud, Mukhopadhyaya, and Sauer) have been calculated for the Herzfeld potential as well as for its UPA. The agreement between the two sets, though satisfactory, is not as good as reported by Levinger and O'Donoghue, who did similar calculations for various singlet potentials. This result may be attributed to the existence of a bound-state pole in the t matrix in the negative-energy region in the case of the Herzfeld potential. (auth)

5146 CONTRIBUTION OF (M + N + ...) SHELLS TO TOTAL INTERNAL CONVERSION COEFFICIENTS FOR TRANSITION ENERGIES ABOVE 500 keV. Dragoun, O.; Brabec, V. (Nuclear Physics Inst., Rez, Czech.). At. Data Nucl. Data Tables; 15: No. 1, 49-56(Jan 1975).

The ratios of internal conversion coefficients (M + N + ...)/L are calculated for atomic numbers Z = 15, 20, ..., 100. Nuclear transition energies from 500 to 4000 keV and multipolarities E1 ... E4, M1 ... M4 are treated. For energies above 1000 keV the internal conversion connected with s electrons was found to play a dominant role, while conversion in the d and f subshells is negligible. The total conversion coefficients are presented in graphical form for the energy interval 200 to 4000 keV. (8 figures, 3 tables) (auth)

5147 GENERATOR COORDINATE METHOD AND NUCLEAR COLLECTIVE MOTIONS. (Lanchow Univ., China). Sci. Sinica (Peking); 17: No. 5, 639-655(Oct 1974).

The generator coordinate method is considered as an approximate method for solving the many-body Schroedinger equation in a subspace. The possibility to make clear the foundations of nuclear models with the generator coordinate method is investigated in general. And the nuclear collective multipole vibrations are studied in some detail as an illustration. (auth)

5148 LOW-LYING STATES OF ODD SPHERICAL NUCLEI. Mitroshin, V. E. (Leningrad Inst. of Nuclear Physics). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2070-2076(Oct 1974). (In Russian).

The variational problem for the description of one-phonon excitation in odd spherical nuclei was formulated and solved with consideration of partial fulfillment of the Pauli principle. It was shown that the abnormal lowering with respect to energy of the term of the vibrational multiplet (j, λ = 2) with total momentum I = j − 1 is caused by the coherent contributions of quasi particles in the forming of the phonon. A comparison with experimental data was made. (2 figures) (tr-auth)

5149 ENERGY OF DEFORMED NUCLEI. Kolomiets, V. M. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2201-2207(Oct 1974). (In Russian).

The behavior of systems in an external deforming field and renormalization of the collective potential energy was examined in the framework of the Bogolyubov–Hartree–Fock approximation. (JSR)

5150 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON REACTIONS BETWEEN COMPLEX NUCLEI. Volume 2. Conference held at Nashville, Tennessee, June 10–14, 1974. Robinson, R. L.; McGowan, F. K.; Ball, J. B.; Hamilton, J. H. (eds.). New York; American Elsevier Publishing Company, Inc. (1974). 688p. (CONF-740637-P2).

Separate abstracts were prepared for 20 of the items in this volume. The remaining six have already been cited in NSA, with the following abstract numbers: 30: 17376, 30: 20166, 30: 20205, 30: 25581, 30: 25691, and 30: 31082. (RWR)

For abstracts of individual papers see: 4163, 4495, 4854, 4894, 4923, 4991, 4992, 5020–5022, 5087, 5151–5158, and 5266.

5151 CLASSICAL AND QUANTUM MECHANICAL DESCRIPTIONS OF HEAVY-ION INTERACTIONS. Glendenning, N. K. (Lawrence Berkeley Lab., CA). pp 137-170 of Proceedings of the International Conference on Reactions Between Complex Nuclei, Vol. 2, Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The discussion of heavy ion interactions between complex nuclei employs classical methods to suggest how the cross section depends on the parameters. Calculations of elastic and inelastic scattering of $^{18}O + ^{120}Sn$ and the two nucleon transfer reaction $^{120}Sn(^{18}O, ^{16}O)$ are performed. The latter results are assumed to be typical of multinucleon transfer. The S-matrix structure as function of l is discussed, and, for reactions involving hundreds of angular momenta, a two part approach to the calculation of the S-matrix is suggested. This approach uses quantum mechanics for the region where the nuclear force is dominant and semi-classical or semi-quantal methods for the high l region where smooth behavior of S permits an interpolation between widely spaced l's. (SDF)

5152 HEAVY-ION INDUCED TRANSFER REACTIONS: THEORY AND SOME DATA. Kahana, S. (Brookhaven National Lab., Upton, NY). pp 189-209 of Proceedings of the International Conference on Reactions Between Complex Nuclei, Vol. 2, Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The transition in heavy ion direct reactions from smooth classical to oscillating quantum mechanical shapes is discussed and data exhibiting strong oscillations in angular distribution at low energies are given. A theoretical analysis in terms of DWBA of a general reaction between rather large nuclei with nonvanishing angular momentum transfer is performed. It appears that absorption and the smallness of the scattering angle play an important role in the amplitude of the fine angular oscillations. Magnetic state (M) populations are calculated for realistic parameters. The analyses rely on a one body treatment in terms of distance between centers of mass. (12 figures) (SDF)

5153 ELASTIC AND INELASTIC TRANSFER REACTIONS. Gobbi, A. (Gesellschaft fuer Schwerionenforschung, Darmstadt, Ger.). pp 211-234 of Proceedings of the International Conference on Reactions Between Complex Nuclei, Vol. 2, Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Elastic and inelastic transfer reaction data is presented and analysis using LCNO and DWBA is discussed. Both treatments yield good results for the elastic exchange of one or two valence nucleons between identical cores of carbon, oxygen and certain other isotopes at bombarding energies near the Coulomb barrier. At slightly higher bombarding energies, inelastic transfer and inelastic collective excitations can be significant. For cases where target and projectile differ by many nucleons, elastic transfer can still be present but occasionally the elastic resonant component dominates. (SDF)

5154 SUB-COULOMB NUCLEAR REACTIONS. Goldfarb, L. J. B. (Univ. of Manchester). pp 283-302 of Proceedings of the International Conference on Reactions Between Complex Nuclei, Vol. 2, Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

Sub-Coulomb transfer reactions and their analysis by the DWBA are discussed. The methods of calculation are described, a survey of the experimentation to date is given, and suggestions concerning future lines of study are made. Corrections to total cross sections due to the Coulomb excitation part of the potential are shown to be significant. The work is illustrated (mostly) by oxygen-induced one-nucleon transfer reactions. (14 figures, 2 tables) (RWR)

5155 INTERFERENCE EFFECTS BETWEEN COULOMB AND NUCLEAR PROCESSES. Broglia, R. A. (Univ. of Copenhagen). pp 303-326 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The topic of interference effects between Coulomb and nuclear processes is reviewed. Elastic and inelastic scattering reactions among heavy ions display angular distributions with very distinctive oscillatory structure; a complete and simple description of these reactions is obtained in terms of a semiclassical theory of the reaction mechanism, based on the phenomenon of Coulomb–nuclear interference. This result requires the existence of a strong nuclear ion–ion potential; it also provides direct evidence for the quantitative importance of multistep processes in heavy-ion reactions. From the point of view of nuclear spectroscopy the Coulomb–nuclear interference phenomenon is shown to be a potentially powerful method for measuring the static quadrupole moments of excited states. The topic is treated under the following headings: the semiclassical approximation, semiclassical treatment of absorption, the ion–ion potential, inelastic form factors, first- and second-order excitations, and interference phenomena. The reaction Ni + O is used for illustrative purposes. The following points may be noted: wiggles in elastic scattering are predicted, as well as the 180° phase rule for inelastic scattering; semiclassical and quantum calculations agree fairly well; and this method can be used to determine Q values. (12 figures) (RWR)

5156 SYSTEMATICS OF MULTI-NUCLEON TRANSFER CROSS SECTIONS. Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 363-381 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The quantity Q/sub gg/ is defined as the energy required to produce a given isotope where both final nuclei are in the ground state. This paper considers the properties of the Q/sub gg/ systematics based on the experimental data of Artukh et al. An attempt is made to interpret them in the framework of the concept of a double-nucleus system produced in the deep inelastic collisions of two nuclei. Cross sections for heavy-ion reactions for Z equals const lie on straight lines as a function of Q/sub gg/; this is illustrated for Z less than 9. All lines have the same slope if pairing is taken into account. (Sequential processes do not fit on the line.) The possibility of using the Q/sub gg/ dependence to estimate the direction of the evolution of the double-nucleus system in compound-nucleus processes as well as in transfer reactions is discussed. (9 figures, 1 table) (RWR)

5157 THEORY OF HIGHLY-INELASTIC TRANSFER PROCESSES. Bondorf, J. P. (Univ. of Copenhagen). pp 383-396 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

When two heavy ions collide with energies well above the Coulomb barrier, they interact strongly and produce many different kinds of products. So far only a few experiments have been done which allow definite conclusions to be drawn with respect to the mechanism of the collisions. Some of the characteristic qualitative features of the experimental cross sections are pointed out first. Then a classical model for the scattering process is presented; colliding liquid drops, the geometry of the classical scattering model, and calculations in the classical scattering model are discussed. Some possible mechanisms for the transfer of nucleons are examined; statistical nucleon transfer and transfer of energy are included. (9 figures, 1 table) (RWR)

5158 PHYSICS OF COMPLEX NUCLEAR INTERACTIONS. Bromley, D. A. (Yale Univ., New Haven). pp 603-664 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

After an introduction containing some general remarks about the present state of heavy ion physics, the bulk of the paper can be divided into the following sections: scattering, reactions, spectroscopy, ultrahigh-energy phenomena, and the question of facilities. Elastic scattering is discussed, and the following open questions are addressed: quasi-molecular resonances, nuclear compressibility, sudden and adiabative limits, coordinate- and velocity-dependent masses; spin–orbit and spin–spin forces, wave equations for higher spins, vacuum polarization effects, shock wave phenomena, and generalized statistics. The section on reactions begins with the observation that lately most nuclear scientists have felt all nuclear reactions to be predominantly direct, in contrast to the situation twenty years ago, when reaction phenomena were assumed to be mostly compound nucleus in origin. The section goes on to consider compound versus direct reaction mechanisms, statistical approaches, direct heavy-ion reactions (inelastic transfer reactions, recoil phenomena, elastic transfer reactions, direct reaction mechanisms, anomalous reactions), complex heavy-ion-induced reactions, resonant fragmentation, transuranic species, supertransuranic species, the fusion process, and high-spin isomeric fission. Then the following aspects of spectroscopy are considered: structural studies in light nuclei, band-crossing phenomena, high-precision spectroscopic studies, giant nuclear multipoles, sharp structure in the continuum, and isobaric multiplet studies. The area of quantum electrodynamics studies may be elucidated by results on quasi-molecular x radiation, spectroscopy with orbiting resonances, and nuclear bremsstrahlung. Speculation is made as to phenomena which might occur at ultrahigh energies. (62 figures, 1 table, 159 references) (RWR)

5159 SINGLE–PARTICLE PROTON WIDTHS OF ISOBARIC ANALOG RESONANCES. Devyatko, Yu. N.; Urin, M. G. (Moscow Engineering Physics Institute). JETP Lett. 20: No. 11, 349-350 (5 Dec 1974).

A formula is proposed, on the basis of the shell model, for single–particle proton widths of isobaric analog resonances; this formula takes into account the approximate conservation of the isospin. It is shown that calculations by this formula are stable against variations of the parameters of the model. (auth)

5160 CORIOLIS INTERACTION IN NUCLEI OF THE TRANSITION REGION. Deleplanque, M. A.; Gershel, C.; Perrin, N.; Quentin, P. (Inst. of Nuclear Physics, Orsay, France). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2022-2024(Oct 1974). (In Russian).

In nuclei of the transition region under given conditions the Coriolis interaction can be sufficiently strong to break the bond of the particles with the core. The Hamiltonian for such interactions was given; the region of applicability of a previously described method for the diagonalization of the Hamiltonian in the |MjR) basis was defined. The method was applied to the calculation of the energy levels of ^{77}Br and ^{135}La with good agreement with experimental results. (JSR)

5161 CONCERNING ONE ANALYTIC PROPERTY OF THE AMPLITUDES OF REACTIONS IN WHICH THREE PARTICLES ARE PRODUCED IN THE FINAL STATE. Baz, A.I.; Merkur'ev, S.P. (Leningrad State University). JETP Lett. 20: No. 11, 348-349 (5 Dec 1974).

We describe the features of the three–particle scattering amplitude (2→3) under the condition that the two–particle subsystems have resonant states. (auth)

5162 GLAUBER APPROXIMATION AND THE PROBLEM OF DIFFRACTION MINIMA. Manaenkov, S.I. (Tula Polytechnic Institute). JETP Lett. 20: No. 11, 351-352 (5 Dec 1974).

The influence of the spin terms and of the momentum–transfer dependence of the nucleon–nucleon amplitude phase on the behavior of the differential cross section for elastic nucleon–nucleus collisions in the region of the diffraction minimum is considered. (auth)

5163 APPEARANCE OF AN ASSOCIATION OF NUCLEONS IN NUCLEAR REACTIONS. Neudachin, V. G. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2010-2021 (Oct 1974). (In Russian).

Experimental data obtained in recent years were compared with the theory of reduced widths (spectroscopic factors) of nucleon association. As an example the reaction $A(d,^6Li)(A-4)_g$, with A from 10 to 40, was discussed, and it was confirmed that the widths rapidly decrease with increase of A. The $^{16}O(^6Li, d)^{20}Ne^*$ reaction was studied, and the predictions of the SU(3) scheme were fulfilled. The good description of the numerous data on (t,p) and (^{3}He,p) reactions was noted. In the high-energy region the theory explains well data on the associative absorption of π mesons and on the quasi-elastic knockout of associations from light nuclei of ^6Li, etc. The potential description of the interaction of bound particles (with the Pauli principle considered,) particularly in their overlapping regions, was discussed. The exclusion of forbidden states in problems outside of the mass surface (3α system and others) was considered. (3 figures, 3 tables, 58 references) (tr-auth)

5164 MAIN POSSIBILITIES OF OBSERVING THE REAL SINGULARITIES OF THE AMPLITUDES OF NUCLEAR REAC-

TIONS. Dubovoi, E. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2065-2069(Oct 1974). (In Russian).

It was shown that the real singularities of the amplitudes of the reaction a + b → c + d, where the singularities are located in a nonphysical region of energy and momentum transfer, can be caused by irregularities in the excitation functions of reactions of the type A + a → B + d, A + a → B' + y + d, A + x → c + d, and A + x' → c + d + z. The observation of these singularities would be experimental proof of the existence of corresponding singularities of the amplitudes of the reaction a + b → c + d. (3 figures) (tr-auth)

5165 ROLE OF THE PAULI PRINCIPLE FOR FORMULATING THE OPTICAL POTENTIAL FOR THE MUTUAL SCATTERING OF CLUSTERS. Kukulin, V. I.; Neudachin, V. G.; Smirnov, Yu. F.; El Khovari, R. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2123-2128(Oct 1974). (In Russian).

The role of the Pauli principle in formulating the optical potential for the scattering of light clusters was examined by using a simple model as an example. On the basis of the equations of the resonating-group method with consideration of complete antisymmetrization, the equivalent local potentials of the interaction of two light clusters were derived, and the relation of these potentials with the properties of the NN force was discussed. (tr-auth)

5166 OFF-ENERGY SHELL BEHAVIOR OF A SINGLE-TERM SEPARABLE ENERGY-DEPENDENT POTENTIAL. Yang, K. H.; Gerace, W. J.; Walker, J. F. (Massachusetts Univ., Amherst (USA)). Nucl. Phys., A; 240: No. 2, 189-194(17 Mar 1975).

Excellent fits to on-shell t-matrix elements of a realistic local potential are obtained using a single-term energy-dependent separable potential in each of five channels. The comparison of half-off-shell t-matrix elements is also very favorable. The optical potential used contains absorption as well as spin-orbit contributions and is appropriate for the low energy n-^{27}Al system. The separable potential is constructed so as to have the correct t-matrix pole locations and residues in each of the five channels. (auth)

5167 E2 POLYNOMIAL STRENGTHS: A COMPARISON WITH SHELL-MODEL RESULTS. Draayer, J. P.; French, J. B.; Potbhare, V. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy); Wong, S. S. M. (Toronto Univ., Ontario (Canada). Dept. of Physics). Phys. Lett., B; 55: No. 4, 349-353(3 Mar 1975).

Polynomial-expansion E2 strengths and sum rules involving (J,T) = (0,0) and (2,0) states of $(ds)^6$ are compared with shell-model results. The agreement is excellent. The strength distribution is describable as a narrow linear ridge in the energy space. The level-to-level fluctuations in the total strength are small, as expected from a theorem of Dyson and Mehta; fluctuations in the first and second moments are also small. The effect of collectivity and the partitioning of the sum rules into exothermic and endothermic parts are discussed. (auth)

5168 GENERATOR COORDINATE CALCULATIONS OF MONOPOLE AND QUADRUPOLE VIBRATIONS WITH SKYRME'S INTERACTION. Flocard, H.; Vautherin, D. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Phys. Lett., B; 55: No. 3, 259-262(17 Feb 1975).

Skyrme's interaction is shown to lead to significant simplifications in generator coordinate calculations. As an illustration, monopole and quadrupole modes are calculated in ^{4}He, ^{16}O and ^{40}Ca using pure oscillator wave functions. (auth)

5169 ON A GROUP-THEORETICAL MISTREATMENT OF GENERALIZED SENIORITY. Talmi, I. (Weizmann Inst. of Science, Rehovoth (Israel)). Phys. Lett., B; 55: No. 3, 255-258 (17 Feb 1975).

A recent paper trying to introduce a group theoretical description of generalized seniority seems to deal with an irrelevant situation. The general results of that paper are derived on the basis of a non-Hermitean Hamiltonian and, apart from the case of the quasi-spin scheme, cannot be applied to shell model Hamiltonians. In the cases of physical interest the nice features of seniority are retained only for a certain set of states. A simple concrete example is presented. (auth)

5170 POLYNOMIAL EXPANSIONS FOR EXCITATION STRENGTHS. Draayer, J. P.; French, J. B.; Potbhare, V. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy); Wong, S. S. M. (Toronto Univ., Ontario (Canada). Dept. of Physics). Phys. Lett., B; 55: No. 3, 263-266(17 Feb 1975).

Rapidly convergent expansions for the strength function of an excitation in a many-particle model space are given in terms of orthogonal polynomials defined by the state or partial state densities of the system. Convergence is assured in a wide range of circumstances by the operation of a central limit theorem. Level-to-level fluctuations are in many cases small, their automatic elimination in the statistical smoothing generated by truncating the series then leading to only small errors. (auth)

5171 PARTON MODEL AND DEEP INELASTIC SCATTERING ON NUCLEI. Nicolaev, N. N. (L. D. Landau Institute for Theoretical Physics, Moscow, USSR); Zakharov, V. I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). Phys. Lett., B; 55: No. 4, 397-399(3 Mar 1975).

The parton model is shown to predict antishadowing phenomena in deep inelastic scattering of electrons or neutrinos off a nucleus. The antishadowing is expected to take place for intermediate values of scaling variable x, $x \approx x_0 \approx 0.05-0.1$, linking the regions of diffraction and incoherent scattering. This effect could account for the experimentally observed lack of shadowing as compared with the predictions of the vector dominance model. The sum rule is proposed according to which the integrated cross section for electron-nucleus interaction is equal to the sum of cross sections for electron-nucleon interactions. (auth)

5172 CALCULATION OF INTERACTION BARRIERS USING THE ENERGY DENSITY FORMALISM. Ngo, C.; Tamain, B.; Galin, J.; Beiner, M.; Lombard, R. J. (Paris-11 Univ., 91-Orsay (France). Inst. de Physique Nucleaire). Nucl. Phys., A; 240: No. 2, 353-364(17 Mar 1975).

Interaction barriers are calculated within the framework of the energy density formalism using the sudden approximation with no adjustable parameters. The experimental data are well reproduced up to $Z_1Z_2 \approx 2700-2800$; above this value, only an estimate can be given, due to changes in the interaction energy curves. A graphical method allowing one to calculate the interaction barriers is proposed. (auth)

5173 DETERMINATION OF THE NUCLEUS-NUCLEUS POTENTIAL FROM BOUNDARY CONDITIONS. Wilczynski, J. (Institute of Nuclear Physics, Krakow (Poland)); Siwek-Wilczynska, K. (Warsaw Univ. (Poland). Instytut Fizyki Doswiadczalnej). Phys. Lett., B; 55: No. 3, 270-272(17 Feb 1975).

The nuclear potential acting between complex nuclei is determined assuming the boundary conditions following from the liquid-drop model. A convenient parametrization of the Coulomb interaction potential is proposed. Both nuclear and Coulomb potentials can be easily calculated for any target-projectile pair without free parameters. (auth)

5174 ^{3}He-n VERTEX CONSTANT AND THE STRUCTURE OF ^{4}He. Lim, T. K. (Drexel Univ., Philadelphia, Pa. (USA)). Phys. Lett., B; 55: No. 3, 252-254(17 Feb 1975).

The asymptotic normalization of the ^{3}He-n relative wave function is evaluated from various sources. The values of $C^2_{^3\mathrm{He}-n}$ converge and yield an averaged magnitude of 16.7. (auth)

5175 ON THE INFLUENCE OF THE NUCLEAR QUADRUPOLE MOMENT ON THE β-DECAY OF DEFORMED NUCLEI. Bergkvist, K. E. (Research Institute for Physics, Stockholm, Sweden). Nucl. Phys., A; 240: No. 2, 334-352(17 Mar 1975).

It is pointed out that in none of the previous treatments of the quadrupole interaction in β decay have the relevant boundary conditions on the final state been recognized or observed. The discrepancy between a purely perturbative treatment and some slightly more exact treatments is shown to stem, ultimately, from this circumstance. Similarly, the basic argument behind the prediction of discontinuities in the β spectra of deformed nuclei is incompatible with the pertaining boundary conditions on the final state. A straightforward adherence to the proper boundary conditions results in discontinuities which, in general, are much smaller than previously anticipated. The failure to see a predicted discontinuity in a reported preliminary experiment on the β decay of ^{170}Tm is entirely understandable, without any assumption of some kind of further hindrance in the decay. (auth)

5176 A FOLDED-DIAGRAM PERTURBATION EXPANSION FOR EFFECTIVE OPERATORS. Krenciglowa, E. M.; Kuo, T. T. S. (State Univ. of New York, Stony Brook (USA). Dept. of Physics). Nucl. Phys., A; 240: No. 2, 195-220(17 Mar 1975).

Linked-diagram expansions for the model-space effective operators are derived for both open-shell nuclei and closed-shell nuclei. These expansions are derived using time-dependent perturbation theory and are given as a diagrammatic series which contains folded diagrams. The results are in general agreement with results obtained earlier by Brandow, but the general structure of the present expansions is perhaps simpler and more convenient for calculations. The projections of the true nuclear eigenfunctions onto the model space are required for the derivation of effective operators. These projections are obtained from the solution of the model-space eigenvalue problem defined by the energy-dependent effective Hamiltonian. Methods for calculating the above diagrammatic series for effective operators are discussed. (auth)

5177 AN ANALYSIS OF BCS SOLUTIONS WITH REALISTIC INTERACTIONS. Das Gupta, S.; De Takacsy, N. (McGill Univ., Montreal, Quebec (Canada). Dept. of Physics). Nucl. Phys., A; 240: No. 2, 293-300(17 Mar 1975).

The principle that the BCS solution can be regarded as a generating function for ground states of neighbouring nuclei is adopted. A parametrisation of the binding energy in terms of the number of particles is assumed, and the assumption, tested. Using an ansatz from statistical mechanics, a formula for the distribution of the number of particles is developed, and the formula is shown to give accurate answers. The concept of temperature is introduced and its interpretation in many-particle theory is clarified. (auth)

5178 MULTIMODAL RESIDUAL INTERACTIONS. Chasman, R. R. (Argonne National Lab., Ill. (USA)). Nucl. Phys., A; 240: No. 3, 425-436(24 Mar 1975).

A multimodal residual interaction consisting of a pairing force and a particle–hole multipole is studied. A modification of the method of correlated quasi-particles is introduced to treat this interaction. The modified form of the method of correlated quasi-particles is found to give good agreement with exact calculations for model systems. (auth)

5179 ONE-BOSON-EXCHANGE-POTENTIAL, EFFECTIVE INTERACTION AND STRUCTURE OF FINITE NUCLEI. Machleidt, R. Bonn; Univ. Bonn (1973). 140p. INIS.

Thesis.

Brueckner theory of nuclear matter and of finite nuclei is considered, and Brueckner reaction matrix is represented as a local potential in an oscillator basis. Calculations and results for ^{16}O and ^{18}O show that the OBEP can successfully be used in nuclear structure calculations. The radii of finite nuclei are slightly smaller compared to the experimental values when using OBEP. The results of this work also show that nuclear matter calculations are a good test of a NN potential. (GE)

5180 GENERAL PROPERTIES OF NUCLEI. pp 7-29 of Legkie i Promezhutochnye Yadra Vblizi Granits Nuklonnoi Stabil'nosti. Baz, A. I.; Gol'danskii, V. I.; Gol'dberg, V. Z.; Zel'dovich, Ya. B. Moscow; Izdatel'stvo Nauka (1972). (In Russian).

A review is given of a number of general characteristics of atomic nuclei. In particular, a discussion is presented on the problems of classifying excited nuclear states, and the isospin and Coulomb components in the energy of atomic nuclei. A description is given of types of instabilities of atomic nuclei, and of the β^+ decay of neutron-deficient nuclei. An analysis is presented of the possibility of finding new forms of radioactive decay of nuclei near the limit of nucleon stability, for example, of proton and double-proton radioactivity. (tr-INIS)

5181 A METHOD FOR THE MULTIPLE SCATTERING CORRECTION IN DOUBLE-DIFFERENTIAL NEUTRON SCATTERING MEASUREMENTS. Demichelis, F.; Raia, G.; Tartaglia, A. (Politecnico di Torino (Italy)). Nucl. Instrum. Methods; 124: No. 2, 375-379(1 Mar 1975).

This paper presents computations of multiple scattering of neutrons from plane slab samples. The analytical procedure derives the differential scattering cross section corrected for the multiple scattering directly from the experimental data. Specific applications of this method to a set of experimental results of the scattering of low-energy neutrons by liquid methane and heavy water are given to illustrate the reliability of the procedure. (auth)

5182 PROGRAM FOR SPECTRA AND CROSS-SECTION CALCULATIONS WITHIN THE PRE-EQUILIBRIUM MODEL OF NUCLEAR REACTIONS. Betak, E. (Slovenska Akademia Vied, Bratislava (Czechoslovakia). Fyzikalny Ustav). Comput. Phys. Commun.; 9: No. 2, 92-101(Feb 1975).

The program calculates particles spectra and/or cross-sections within the pre-equilibrium model of nuclear reactions using the master-equation approach to the model. The complex particles and the competition among various channels are also included in the calculation. In the first part of the program, the emission rates for all outgoing channels and the transition rates are calculated. They enter the set of master equations describing the equilibration process and the decay. This set is solved by an iteration and after reaching the equilibrium its solution is extrapolated in time to infinity. Finally, the desired particle spectra and/or cross sections are calculated. (auth)

5183 THEORY OF NUCLEAR FRICTION. Gross, D. H. E. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Bereich Kern- und Strahlenphysik). Nucl. Phys., A; 240: No. 3, 472-484(24 Mar 1975).

From the general many-body Schroedinger equation for colliding heavy ions a classical equation of motion including frictional forces is deduced. It is argued that one of the main origins of friction between two colliding heavy ions is the reflection of nucleons off the moving edges of the single-particle potentials. A simple classical analog is given which illustrates how friction appears. (auth)

5184 CALCULATION OF SPECTROSCOPIC AMPLITUDES USING BOSON EXPANSION WAVE FUNCTIONS. Braunschweig, D. (Michigan Univ., Ann Arbor (USA). Cyclotron Lab.). Nucl. Phys., A; 240: No. 3, 457-471(24 Mar 1975).

A formalism is derived which allows the evaluation of spectroscopic amplitudes for two-nucleon transfer reactions. The transfer is assumed to take place between low-lying collective states described by boson expansion wave functions. Numerical calculations have been performed for (t,p) reactions on $^{148,150,152}Sm$. Excellent agreement is obtained for cross sections leading to the ground state in the residual nucleus. (auth)

5185 ANALYSIS OF E1 RADIATIVE NEUTRON CAPTURE BASED ON THE OPTICAL MODEL. Barrett, R. F.; Terasawa, T. (Australian National Univ., Canberra. Research School of Physical Sciences). Nucl. Phys., A; 240: No. 3, 445-456(24 Mar 1975).

The optical model formula of Lane and Mughabghab for E1 radiative neutron capture has been applied to resonance capture in ^{56}Fe and ^{90}Zr. It is shown that in general the optical model predicts the contributions to the radiative widths which are correlated with the neutron widths, except for a depletion factor α representing the proportion of E1 single-particle strength remaining near the neutron threshold. The degree of correlation between measured and calculated radiative widths is related to the ratio of the variances of these widths. This enables an estimate of the factor α. It is shown that the theoretical value for the ratio of the radiative to neutron widths is to a good approximation independent of the imaginary part of the optical potential. The calculated radiative width is thus well defined. The results are compared with those from the valence model and from experiment. The direct background contribution is found to be negligible compared to the average compound cross section. The contribution of d-waves to the radiative capture cross section is discussed. (auth)

5186 SHELL MODEL FORMULATION OF REACTIONS WITH TWO NUCLEONS IN THE CONTINUUM. Eppel, D. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Experimentalphysik); Lindner, A. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Theoretische Physik). Nucl. Phys., A; 240: No. 3, 437-444(24 Mar 1975).

The shell model is extended to the case of two nucleons in the continuum, including deuteron scattering, break-up and stripping reactions. For the various transition amplitudes uncoupled Lippmann–Schwinger equations with completely connected kernels are derived, usable for numerical calculations. (auth)

5187 MICROSCOPIC DESCRIPTION OF RADIATIVE PION CAPTURE IN NUCLEI. Delorme, J.; Ericson, M. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire); Faeldt, G. (Institute for Theoretical Physics, Lund, Sweden). Nucl. Phys., A; 240: No. 3, 493-520(24 Mar 1975).

The radiative capture of pions in nuclei has been investigated by a microscopic method. It has been shown that the elementary nucleonic amplitude is renormalized by two effects: (i) The effective field correction which takes into account the incoherent scattering of the pions before the absorption. This correction differs for the short-ranged and long-ranged part of the interaction. (ii) The meson exchange corrections have been introduced where the pion interacts with a nucleon which exchanges a pion with the neighboring nucleons. The introduction of this correction makes the microscopic description and the soft-pion one equivalent for pions at rest. (auth)

5188 OFF-SHELL CORRECTIONS TO THE GLAUBER THEORY OF NUCLEAR MULTIPLE SCATTERING. Schuermann, B. (Heidelberg Univ. (F. R. Germany). Inst. fuer Theoretische Physik). Nucl. Phys., A; 240: No. 3, 521-532(24 Mar 1975).

The first-order off-shell corrections to Glauber's multiple scattering model are studied. These consist of a direct and a rescattering term, and are obtained from the eikonal corrections studied in a previous paper by a simple substitution. For an independent-particle nuclear model the direct term becomes identical to an expression previously derived by Moniz. It is shown that the rescattering term is in general not small compared to the direct term. For high incident energy a comparison is made with other corrections to the Glauber model. An optical potential is proposed which consists of the Glauber potential and its off-shell, eikonal, Fresnel and spatial correlation corrections. (auth)

5189 ON THE ANALYTICAL UNFOLDING OF GENERATOR COORDINATE KERNELS FOR UNEQUAL FRAGMENTS. Gi-

raud, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); LeTourneux, J. (Montreal Univ., Quebec (Canada). Lab. de Physique Nucleaire). Nucl. Phys., A; 240: No. 3, 365-372(24 Mar 1975).

The generator coordinate formalism breaks down for scattering and reactions involving fragments of unequal size. Analytical expressions are given through which, even in that case, the resonating group kernels can be extracted from those of the generator coordinate method. The possibility of defining a generator coordinate density matrix is discussed. (auth)

5190 DIRECT REACTIONS TO MANY-CHANNEL, MANY-LEVEL FINAL STATES. II. (d,p)n and (^{3}He,d)p. Treacy, P. B. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Nucl. Phys., A; 240: No. 3, 413-424(24 Mar 1975).

In an earlier paper, the cross section for a direct reaction to a generalized positive-energy final state, described by an R-matrix wave function, was derived. Here a distinction is emphasized between two classes of such a reaction, depending on whether it can or cannot decay back to the target state. A major contribution in the latter case can be via direct break-up. This is computed for the reaction ^{7}Li(^{3}He,d)^{8}Be(p)^{7}Li, treated by a stripping mechanism. The dependence of the cross section on the final-state (^{8}Be) channel energy is discussed. The present work uses shell-model wave functions for R-matrix basis states, and this is shown to be appropriate and useful for direct reactions. (auth)

5191 RADIOACTIVE DECAYS WITH PROTON EMISSION. pp 111-143 of Legkie i Promezhutochnye Yadra Vblizi Granits Nuklonnoi Stabil'nosti. Baz, A. I.; Gol'danskii, V. I.; Gol'-dberg, V. Z.; Zel'dovich, Ya. B. Moscow; Izdatel'stvo Nauka (1972). (In Russian).

The decrease in proton binding energy on going to the lighter neutron-deficient nuclei having a given charge Z leads to the occurrence of three new phenomena in nuclear physics: (1) emission of delayed protons; (2) proton radioactivity; and (3) two-proton radioactivity. The emission of delayed protons, which has already been successfully observed in a number of cases, is still a complex, two-step process of beta decay, which is analogous to the previously known emission of delayed neutrons and to the emission of delayed (long-range) alpha particles by light nuclei. Proton and two-proton radioactivities are new types of elementary events of the radioactive decay of nuclei which have not yet been investigated experimentally. (tr-auth)

5192 THE EFFECTIVE INTERACTION FOR UNBOUND NUCLEONS AND THE OPTICAL POTENTIAL. Manweiler, R. W. (Cornell Univ., Ithaca, N. Y. (USA). Lab. of Nuclear Studies). Nucl. Phys., A; 240: No. 3, 373-412(24 Mar 1975).

The effective interaction for an unbound nucleon in a complex nucleus is studied with particular emphasis upon the relationship of the unbound-state interaction with the interaction for bound states. A successful unified treatment of unbound and bound states is given, and the unbound-state effective interaction is related to the standard "optical model." The attractive force for an unbound nucleon is shown to be of an exchange type and is best represented by a non-local, energy-independent potential which can be calculated, at least for not too high incident nucleon energy, from the attractive interaction between bound nucleons in a nucleus. The unbound-state potential is related to the bound-state effective force as calculated by Negele by using Hartree–Fock theory. A non-local potential used by Elton, Webb, and Barrett in a successful analysis of electron scattering is shown, with minor modification, to work remarkably well in an analysis of elastic scattering of protons. Excellent agreement with experiment is obtained for the differential cross section and the polarization of protons with an incident energy up to 60 MeV scattered from ^{40}Ca, ^{58}Ni, ^{120}Sn and ^{208}Pb. The real potential parameters are shown to be independent of the incident energy and physically reasonable; the imaginary potential parameters agree with expectations from Fermi gas and collective models. Bound-state energy levels are also calculated with no readjustment of the real potential parameters in order to check the consistency of the interaction with the bound states, and the results are in good agreement with Negele. The interaction of Skyrme as modified by Vautherin and Brink is also used in an analysis of elastic proton scattering. Good results are obtained for the differential cross section and the polarization for 20 MeV protons scattered from ^{58}Ni. At higher incident proton energy, and for larger nuclei, the results are poorer. (auth)

5193 THE INFLUENCE OF MANY-QUASI-PARTICLE STATES AT LOW ENERGY. Arvieu, R.; Manfredi, V. R. (Paris-11 Univ., 91–Orsay (France). Inst. de Physique Nucleaire). Nucl. Phys., A; 239: No. 2, 301-320(24 Feb 1975).

The magnitude of the frequency functions corresponding to subspaces containing up to 16 quasi-particles is studied in a region of energy where the two-quasi-particle and the BCS states are located. The assumption of normality for the frequency functions is discussed and is seen not to play a crucial role in the problem of the mixing of these subspaces. The influence of the states with a high number of quasi-particles is seen to be very important in that region. This importance must be reduced if spurious states are properly extracted. (auth)

5194 LEPTODERMOUS DISTRIBUTIONS VERSUS NON-SATURATING FORCES. Vinas, F. J.; Madurga, G. (Barcelona Univ. (Spain). Facultad de Ciencias). Nucl. Phys., A; 240: No. 1, 109-119(10 Mar 1975).

A criterion is given to determine unequivocally the bulk value of a leptodermous distribution. The inability of the Thomas-Fermi approximation to give the right surface thickness is shown. Finally, the leptodermicity of nuclear densities is used to prove the nonsaturating character of density-independent nucleon-nucleon interactions. (auth)

5195 EFFECTIVE DENSITIES IN LOCAL-DENSITY APPROXIMATIONS OF THE NUCLEON–NUCLEON EFFECTIVE INTERACTION. Wong, C. W.; Moszkowski, S. A. (California Univ., Los Angeles (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 2, 209-220(24 Feb 1975).

The choice of an effective local density for a finite-range density-dependent effective interaction is considered. The effect appears in the second-order perturbation energy for a density-independent bare force. Analysis of this energy shows that other finite-nucleus effects are more important than the uncertainties arising from the use of a c.m. density, or arithmetic or geometric mean density. The latter uncertainties are found to be $\frac{1}{4}$- 1 MeV/A for most nuclei. Since the actual uncertainties in fitted phenomenological interactions are only a fraction of these, it is felt that any of these local densities can be used without introducing large errors. (auth)

5196 NUCLEAR COMPRESSION MODULI AND DENSITY-DEPENDENT FORCES. Faessler, A.; Galonska, J. E. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik); Goeke, K. (Oxford Univ. (UK). Dept. of Theoretical Physics); Moszkowski, S. A. (California Univ., Los Angeles (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 3, 477-488(3 Mar 1975).

Density-dependent zero-range forces of the form of the modified delta interaction (MDI) are generalized (MDI3, MDI4) in order to yield reasonable values of the compression modulus in nuclear matter (K_N = 200 MeV). This low value can be fitted by introducing two terms with different density dependence in the force. The four free parameters of MDI3 are adjusted to reproduce the nuclear matter values of the binding energy, density and compression modulus, and to fulfill the condition that the total energy of ^{16}O in harmonic oscillator wave functions has a minimum at the oscillator length b = 1.75 fm, corresponding to the correct rms radius. MDI4 contains in addition a two-body spin–orbit interaction. The five parameters of MDI4 are fitted to the above three nuclear matter data and by requiring that Hartree–Fock (HF) calculations in ^{208}Pb yield the experimental charge rms radius and reasonable values of certain single-particle spin–orbit splittings. The quality of MDI4 is checked by comparing calculated rms radii, binding energies, and elastic electron scattering cross sections with available experimental data for doubly closed shell nuclei. As a test the energy levels and the nuclear monopole polarization of muonic ^{208}Pb are calculated self-consistently and yield impressive agreement with experiment. (auth)

5197 IMPEDANCE MISMATCH FOR THE SCATTERING OF HEAVY IONS CALCULATED WITH DEEP AND STRONGLY ABSORBING POTENTIALS. Gelbke, C. K. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Phys. Lett., B; 55: No. 2, 134-136(3 Feb 1975).

For deep and strongly absorbing potentials reflection from the surface of the potentials gives the dominant contribution to the scattering of the low partial waves. This effect is not treated in semiclassical theories. (auth)

5198 REGGE-POLE DOMINANCE IN A HEAVY-ION DWBA CALCULATION. Fuller, R. C. (Brookhaven National Lab., Upton, N. Y. (USA)); McVoy, K. W. (Wisconsin Univ., Madison (USA)). Phys. Lett., B; 55: No. 2, 121-124(3 Feb 1975).

Regge-pole dominance is shown in a representative heavy-ion DWBA calculation and various pole manifestations in both calculated elastic and transfer quantities are displayed. (auth)

5199 SINGLE-PARTICLE ENERGIES, LARGE-MATRIX DIAGONALIZATIONS AND PERTURBATION THEORY OF NUCLEAR EFFECTIVE INTERACTIONS. Starkand, Y.; Kirson, M. W. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics). Phys. Lett., B; 55: No. 2, 125-128(3 Feb 1975).

The two-body effective interaction obtained from extended shell-model calculations is tested for sensitivity to single-particle energies. Corrections are applied for disconnected diagrams, and the contributions of folded and nonfolded diagrams are computed separately. (auth)

5200 EVIDENCE FOR THE QUASIPARTICLE-PHONON INTERACTION IN ODD-MASS DEFORMED NUCLEI. Andrejtscheff, W.; Manfrass, P. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Phys. Lett., B; 55: No. 2, 159-161(3 Feb 1975).

A specific mass-number dependence of the absolute transition rates for E2, $\Delta K = 2$ and E1, $\Delta K = 0$ transitions in odd-mass deformed nuclei was found. The effect is interpreted as a result of the quasiparticle-phonon interaction. (auth)

5201 THE DEPENDENCE OF SHELL MODEL STATE DENSITIES ON ANGULAR MOMENTUM. Ginocchio, J. N.; Yen, M. M. (Yale Univ., New Haven, Conn. (USA). Nuclear Structure Lab.). Nucl. Phys., A; 239: No. 3, 365-396(3 Mar 1975).

The centroid and second through fourth central moments of shell model state densities are shown to have a very simple dependence on the projection of the angular momentum along the z axis. This simple dependence follows from the fact that the single-particle angular momenta add statistically for a large number of nucleons. (auth)

5202 REMARKS ON THE KINEMATICS FOR THE EVALUATION OF THE PION–NUCLEUS OPTICAL POTENTIAL. Schmit, C.; Dedonder, J. P.; Maillet, J. P. (Paris-11 Univ., 91–Orsay (France). Inst. de Physique Nucleaire). Nucl. Phys., A; 239: No. 3, 445-466(3 Mar 1975).

Using the coherent scattering and impulse approximations, the pion–nucleus optical potential is evaluated for non-relativistic pions. It is shown that, due to Galilean invariance, this potential is non-local even for the part originating from the pion–nucleon S-wave scattering. In addition, Galilean invariance introduces in the potential a term depending on the momentum transfer. A possible extension of these results to the case of relativistic pions is presented, pointing out the difficulties related to this problem. (auth)

5203 A SIMPLE MODIFIED LOCAL PION–NUCLEUS OPTICAL POTENTIAL. Kujawski, E. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Physics). Nucl. Phys., A; 239: No. 3, 467-476(3 Mar 1975).

A simple local π-nucleus optical potential is developed using the Thomas–Fermi approximation. The internal motion and binding of the target nucleons and effects due to the Pauli principle are accounted for. Using a simple but realistic parametrization for the P_{33} resonating amplitude, the above model is evaluated for $\pi^- - {}^{12}C$ scattering in the region of the (3,3) resonance. Reasonable fits to the data are obtained with no adjustable parameters. The effects of the internal motion and binding of the target nucleons and the Pauli principle are small at the higher energies ($T_L > 150$ MeV), and most significant at the larger momentum transfers. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 3544, 3698, 3719, 3720, 4048, 4158, 5091, 5102, and 5181.

5204 (AED-CONF-74-509-040) THE CALCULATION OF FLUENCE, LET, AND EVENT SIZE SPECTRA FOR NEUTRON BEAMS. Edwards, A. A. (National Radiological Protection Board, Harwell (UK)). 1974. 10p. INIS.

From 2nd symposium on neutron dosimetry in biology and medicine; Neuherberg/Muenchen, F. R. Germany (30 Sep 1974).

The paper presents results from a computer program which has been written to calculate by an analytical method the secondary charged-particle spectra, the slowing-down spectra (fluence) and the dose distribution in LET when neutron spectra irradiate materials of dosimetric interest. The same program proceeds to calculate the pulse height responses of a spherical proportional counter irradiated by neutron spectra. The program uses published cross-section data for neutron interactions with hydrogen, carbon, nitrogen and oxygen, and combines them with stopping power data for the target material derived from elemental stopping powers using the Bragg additivity rule. The calculation of the pulse height response takes into account the variation of the W value with energy. Fluence spectra and LET spectra are given for 14.7-MeV, californium-252 and cyclotron-generated neutron spectra when they irradiate standard man tissue, tissue-equivalent plastic and water. The computed pulse height response of a spherical proportional counter made from Shonka plastic and filled with tissue-equivalent gas is presented for californium-252 neutrons and compared to a practical measurement. The differences between the two spectra are emphasized; and possible causes for the discrepancies, discussed. Agreement between the two spectra is sufficiently good to give confidence both in the method of calculation and in the experimental apparatus. (GE)

5205 (WANL-TME-2706) CODE DESCRIPTION AND USER'S MANUAL FOR THE MAP RADIATION TRANSPORT COMPUTER CODE. Disney, R. K.; Soltesz, R. G.; Jedruch, J.; Zeigler, S. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1970. 194p. Dep. NTIS $12.75.

The MAP computer code for solving energy-dependent radiation transport external to a nuclear radiation source is described. The MAP code uses the discrete ordinate transport code DOT-IIW (or DOT-II) multigroup, angular-dependent, surface leakage fluxes in an r, z geometry solution as energy-and angular-dependent, surface source data. The code has the capability to 1) integrate over the visible source surface to obtain detector response at detector surfaces, and 2) apply attenuation functions in geometries external to the r, z DOT-IIW problem geometry. Detailed user information including setup, running time, required input data, and recommended use is provided. Problem setup information including input tapes as well as a description of printed, punched, and tape output is described. A sample problem card input and printout for the MAP code as well as a companion DOT-IIW problem card input and printout are included. (auth)

5206 ENERGY LOST TO IONIZATION BY 254-eV ^{73}Ge ATOMS STOPPING IN Ge. Jones, K.W.; Kraner, H.W. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. A 11: No. 4, 1347-1353 (Apr 1975).

A 1-cm^3 Ge(Li) γ-ray detector was placed directly in a beam of thermal neutrons, where the ^{72}Ge$(n, \gamma)^{73}$Ge reaction produced 254-eV ^{73}Ge recoil atoms in the detector. The primary capture γ rays from the reaction were detected in a 7.6-cm × 7.6-cm NaI(Tl) detector placed at 90° to the incident beam. In addition to singles measurements a coincidence between the primary capture γ ray and the γ ray or conversion electrons from the decay of the 68.75-keV ^{73}Ge third excited state was used to search for directional effects in the stopping and to check the value of the recoil energy deduced from the feeding of the 68.75-keV level. The level energy was remeasured and a value of 68.755 ± 0.005 keV was found, which when combined with the results of previous work gives a value of 68.7535 ± 0.0043 keV. The amount of energy lost to ionization in the stopping of the 254-eV ^{73}Ge atom is found from the energy shift in the peak position for the 68.75-keV level. Our measurement of this shift gives a value of 39.2 ± 5.5 eV, which is then the energy loss to ionization by the stopping of the 254-eV ^{73}Ge recoil atom. This result is (27 ± 3) % higher than the theoretical estimate made from an extrapolation of the Lindhard theory to this energy region. An attempt to observe a dependence of the ionization loss on the recoil direction in the Ge crystal was made, but no positive effect was observed. (auth)

5207 CHARACTERISTIC LOSSES OF ELECTRON ENERGY IN URANIUM AND URANIUM DIOXIDE. Bakulin, E.A.; Balabanova, L.; Bredov, M.M.; Stepin, E.V. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). Sov. Phys.—Solid State 16: No. 9, 1670-1671 (Mar 1975).

Spectra of the characteristic losses of electron energy in uranium and uranium dioxide have been obtained for the first time by transmitting 25-keV electrons through film samples. The energy losses are explained by various excitations in these materials. It has been found that 5*f* electrons participate in plasma oscillations and in the formation of the conduction band in uranium. The polarizability of the ion radical in UO_2 has been calculated from the bulk plasmon energy as $\beta = 2.2 \cdot 10^{-24}$ cm^{-3}. (auth)

5208 PROCESS OF THE TWO-PHOTON BREMSSTRAHLUNG OF THE ELECTRON IN THE FIELD OF A NUCLEUS WITH FINITE DIMENSIONS. Nadzhafov, I. M. (Azerbaidzhan State Univ., Baku). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 10, 2191-2196 (Oct 1974). (In Russian).

The angular and energy dependences of the cross section for two-photon bremsstrahlung of the electron on the nuclear dimensions were studied for homogeneous, Gaussian, and exponential distributions of the charge in the nucleus. (tr-auth)

5209 THE MEASUREMENT OF Pb^+ ION COLLECTION IN Si BY HIGH DEPTH-RESOLUTION RUTHERFORD BACKSCATTERING. Williams, J. S. (Salford Univ. (UK)). Phys. Lett., A; 51: No. 2, 85-86(10 Feb 1975).

Pb distributions for 20 keV Pb^+ implantations into Si have been measured as a function of dose by glancing angle Rutherford backscattering. For Pb doses in excess of 10^{15} ions cm^{-2}, Pb accumulation at the target surface has been observed. (auth)

5210 ENERGY LOSSES OF CHANNELED PARTICLES AT HIGH ENERGIES. Kumakhov, M. A.; Wedell, R. (Moskovskij Gosudarstvennyj Univ. (USSR). Inst. Yadernoj Fiziki); Komarov, F. F. (Belorusskij Gosudarstvennyj Univ., Minsk). Phys. Lett., A; 51: No. 3, 151-152(24 Feb 1975).

The ratio of the energy loss of channeled particles to the energy loss in the amorphous medium has been calculated including relativistic corrections. In the limit of high velocities, the ratio has been shown not to tend to unity. (auth)

5211 RANGE PARAMETERS OF HEAVY IONS AT 10 AND 35 keV IN SILICON. Feuerstein, A.; Kalbitzer, S.; Oetzmann, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany)). Phys. Lett., A; 51: No. 3, 165-166(24 Feb 1975).

Since ion implantation of low-energy heavy ions has become an important technology for doping semiconductors, increasing effort has been paid to obtain precise values of range parameters. Projected ranges and range straggling of Ge and As ions with LSS energies of $\epsilon < 0,2$ have been measured with backscattering techniques using a high-resolution electrostatic analyzer. (auth)

5212 ENERGY LOSS MEASUREMENTS OF keV-IONS IN GASES BY TIME-OF-FLIGHT SPECTROSCOPY. Martini, V. (Bonn Univ. (F. R. Germany). Inst. fuer Strahlen- und Kernphysik). Nucl. Instrum. Methods; 124: No. 1, 119-124(15 Feb 1975).

A time-of-flight technique which allows a fast and precise measurement of the stopping power of gases for keV ions has been developed. First results are reported for the stopping cross-section of lead ions in helium gas in the energy range 25 keV ≤ E ≤ 75 keV. The data are compared with the Lindhard theory. (auth)

5213 CALCULATION OF MULTIPLE SCATTERING OF CHARGED PARTICLES ALLOWING FOR ENERGY LOSS AND A HOMOGENEOUS LONGITUDINAL MAGNETIC FIELD. Daniel, H. (Los Alamos Scientific Lab., N. Mex. (USA)). Nucl. Instrum. Methods; 124: No. 1, 253-255(15 Feb 1975).

The multiple scattering of charged particles has been calculated taking energy loss into account. A homogeneous magnetic field parallel to the beam axis may be present. The results apply also to scattering media varying along the beam axis. Closed-form results and numerical values are given for the stopping distributions of fast electrons and nonrelativistic heavy particles. A magnetic field of 20 kG reduces noticeably the mean spread of electron beams; for heavy particles very strong magnetic fields are required. The reduction in beam size may be of value in radiotherapy. (auth)

5214 ENERGY STRAGGLING OF FISSION FRAGMENTS IN GASES AND SOLIDS. Al-Bedri, M. B.; Harris, S. J. (Surrey Univ., Guildford (UK)). Nucl. Instrum. Methods; 124: No. 1, 125-130(15 Feb 1975).

A ^{252}Cf spontaneous fission source and a heavy-ion surface barrier detector have been used to measure the straggling parameters for light and heavy fragments transmitted through a number of gases, gas mixtures, and solids. (auth)

5215 SMALL ANGLE MULTIPLE SCATTERING OF 12-40 MeV HEAVY IONS FROM THIN FOILS. Hooton, B. W.; Freeman, J. M.; Kane, P. P. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Nucl. Instrum. Methods; 124: No. 1, 29-39(15 Feb 1975).

The angular distributions of collimated beams of heavy ions after passing through thin foils have been measured with a position sensitive silicon detector. Beams of O, Cl and Fe from the Harwell tandem generator were used, at energies in the range 12-40 MeV, with scattering foils of C, Al, Ni, and Au of effective thicknesses between 12 and 250 $\mu g/cm^2$. Values obtained for the half-angles at half height of the distributions are in fair agreement with the theoretical calculations of Meyer and are much smaller than those computed on the basis of the theory of Nigam, Sundaresan and Wu. The detailed shapes of the multiple scattering angular distributions agree reasonably well with the predictions of the Meyer theory. (auth)

5216 ON THE RESTRICTED ENERGY LOSS OF RELATIVISTIC CHARGED PARTICLES IN MATTER. Alakoz, A. V.; Chechin, V. A.; Kotenko, L. P.; Merson, G. I.; Yermilova, V. C. (AN SSSR, Moscow. Fizicheskij Inst.). Nucl. Instrum. Methods; 124: No. 1, 41-47(15 Feb 1975).

The Bethe–Block formula with density effect correction which describes the restricted energy loss of relativistic charged particles in matter is extended to the case when the upper energy transfers in single collisions are of the order of or less than the binding energy of atomic inner shell electrons. (auth)

5217 ATTENUATION OF MONOENERGETIC GAMMA RAYS IN TISSUES. Rao, P. S.; Gregg, E. C. (Case Western Reserve Univ., Cleveland). Am. J. Roentgenol., Radium Ther. Nucl. Med.; 123: No. 3, 631-637(Mar 1975).

Using gamma-emitting radioisotopes and a crystal spectrometer linear attenuation coefficients were measured for a variety of tissues at photon energies of 27, 60, 122, 279, and 662 keV. The fractional standard deviations of the observed values varied with tissue thickness, but were about 0.5% in most of the cases. Specific gravities of the tissue samples were measured wherever feasible. Results indicate that the attenuation coefficients of different parts of the same organ may vary by up to 1%. For most of the tumors investigated, no significant differences were found between the attenuation coefficients of cancerous tissues and their normal parenchyma. Some attenuation coefficients were measured for a few of the materials commonly used as phantom materials. (auth)

5218 EQUILIBRIUM CHARGE-STATE DISTRIBUTIONS FOR ^{16}O IONS AT 20–65 MeV. Weber, D. J.; Hintz, N. M.; Dehnhard, D. (Minnesota Univ., Minneapolis (USA). John H. Williams Lab. of Nuclear Physics). Nucl. Instrum. Methods; 124: No. 2, 317-319(1 Mar 1975).

Equilibrium charge-state distributions for 20–65-MeV ^{16}O ions scattered off carbon-backed gold targets were measured. Significant differences were found between the experimental results and calculated values based on the semi-empirical theory of Zaidins. (auth)

5219 MONTE CARLO STUDY OF MULTIPLE SCATTERING OF PHOTONS IN COMPTON PROFILE MEASUREMENTS. Felsteiner, J.; Pattison, P. (Warwick Univ., Coventry (UK). School of Physics). Nucl. Instrum. Methods; 124: No. 2, 449-453(1 Mar 1975).

A Monte Carlo calculation is made of the amount of multiple scattering in Compton profile measurements. Various experimental conditions are considered, including variation of sample thickness, sample material and incident photon energy. From the results it is possible to show how experiments can be designed to minimize multiple scattering. The mean free path of the incident photons in the scattering material is shown to play an important role in determining the contribution from multiple scattering. (auth)

5220 CALCULATION OF THE VAVILOV DISTRIBUTION. A Correction. Adams, J. H. Jr.; Silberberg, R. (Naval Research Lab., Washington, D. C. (USA)); Badhwar, G. D. (National Aeronautics and Space Administration, Houston, Tex. (USA). Manned Spacecraft Center). Nucl. Instrum. Methods; 124: No. 2, 551-556(1 Mar 1975).

The probability distribution for energy deposition in absorbers, allowing for electron escape, has been recalculated. This calculated distribution is compared with an experimental one generated by muons in a pilot Y plastic scintillator. A computer program to calculate the distribution is given. (auth)

5221 GENERALIZED HYDRODYNAMICS FOR THE DIFFUSION PROCESS. de Schepper, I. Nijmegen, Netherlands; Katholieke Univ. (1974). 221p.

Thesis.

The self-diffusion process is studied theoretically by means of a function $G(\vec{r},t)$, which is the probability of finding a tagged particle at time t at the position $\vec{r}$. The hydrodynamic equation used is Fick's law, which is derived and extended. Kinetic theory of hard spheres at low densities and mode coupling theory are employed. It is shown from kinetic theory that the super Burnett coefficient does not exist both in two and three dimensions. (NL)

Radiation Protection Standards

Refer also to abstracts 3716, 3721, and 3729.

Radiation Source Calibration and Standardization

Refer also to abstracts 4773, 4930, 4977, 4993, and 5078.

5222 THEORETICAL CONSIDERATIONS FOR STANDARDIZATION OF ^{125}I BY THE COINCIDENCE METHOD. Horrocks, D. L.; Klein, P. R. (Scientific Instruments Division, Beckman Instruments, Inc., Irvine, CA 92644, U. S. A.). Nucl. Instrum. Methods; 124: No. 2, 585-589(1 Mar 1975).

The decay scheme of ^{125}I is analyzed. The probabilities of emission are calculated for each of the several pathways of ^{125}I decay. The equation for calculation of the source decay rate by the coincidence method is derived from these probabilities. (auth)

Shielding Calculations and Experiments

Refer also to abstracts 4775, 5102, and 5385.

PHYSICS (THEORETICAL)

General

Refer also to abstracts 4605 and 4623.

5223 (ITEF-90) UNIFORM APPROXIMATION IN POLYNOMIAL SUPERPOSITION OF N POWER SERIES. Mironiv, S. V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 40p. (In Russian). Dep. NTIS (US Sales Only) $5.00.

Proof is given of the theorem of uniform approximation by an algebraic polynomial of n-degree on substituting a power series in a power series. As an example the coefficients are approximated in the decomposition of an averaged, perturbing function in the three-body problem. (SJR)

5224 (WANL-TME-1515) ISUDS—ITERATIVE SCHEME USING A DIRECT SOLUTION. Collier, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1966. 14p. Dep. NTIS $4.00.

ISUDS is a digital computer program that gives an accurate solution, to a large system of simultaneous, linear, algebraic equations. This report is a demonstration on how to find a solution, and increase its accuracy using a direct method of computation. The prime reason for increasing the accuracy of a solution (instead of using a double-precision, direct method), is that it is possible to gain double accuracy while using a single-precision coefficient matrix. This program is based on a principle described by Hamming. (auth)

5225 RATIONAL CHEBYSHEV APPROXIMATIONS FOR THE MODIFIED BESSEL FUNCTIONS $I_0(x)$ AND $I_1(x)$. Blair, J. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Math. Comput.; 28: No. 126, 581-583(Apr 1974).

This note presents nearly-best rational approximations for the functions $I_0(x)$ and $I_1(x)$, with relative errors ranging down to 10^{-23}. (auth)

5226 DIRECT SOLUTION OF THE BIHARMONIC EQUATION ON RECTANGULAR REGIONS AND THE POISSON EQUATION ON IRREGULAR REGIONS. Buzbee, B. L.; Dorr, F. W. (Los Alamos Scientific Lab., NM). Contract W-7405-eng-36. SIAM (Soc. Ind. Appl. Math). J. Numer. Anal.; 11: No. 4, 753-763(Sep 1974).

The discrete biharmonic equation on a rectangular region and the discrete Poisson equation on an irregular region can be treated as modifications to matrix problems with very special structure. It is shown how to use the direct method of matrix decomposition to formulate an effective numerical algorithm for these problems. For typical applications the operation count is $O(N^3)$ for an N x N grid. Numerical comparisons with other techniques are included. (auth)

5227 NUMERICAL METHODS FOR NONLINEAR VOLTERRA INTEGRODIFFERENTIAL EQUATIONS. Feldstein, A. (Arizona State Univ., Tempe); Sopka, J. R. SIAM (Soc. Ind. Appl. Math.) J. Numer. Anal.; 11: No. 4, 826-846(Sep 1974).

From SIAM fall meeting; Philadelphia, PA (Oct 1968).

Let u'(x) equals f(x,u(x), Iu(x)) and u(a) equals mu, the initial value, where I is the Volterra functional Iu(x) equals integral /sub a//sup x/k(x, s, u(s)) ds. Call this the general nonlinear Volterra integro-differential equation (VIDE). Approximations are given for the functional I and its derivatives. These approximations are applied to create one-step algorithms for the constructive solution of the VIDE problem. Let x epsilon[a, b], integer N greater than or equal to 1, and h equals (b - a)/N. Define x/sub n/ equals a + nh for n equals 0(1)N. A class of algorithms (each depending upon an order parameter p greater than or equal to 1 and upon the step size h) are defined. For each fixed p and h, each algorithm recursively generates a sequence (u/sub n/) which approximates (u(x/sub n/)). Two error propagation theorems are presented. THEOREM 1. Under suitable smoothness conditions, u/sub n/ equals u(x/sub n/) + O(h/sup p/), where p greater than or equal to 1 is the order parameter. The convergence is uniform on closed intervals. THEOREM 2. Under further smoothness conditions, u/sub n/ equals u(x/sub n/) + h/sup p/e(x/sub n/) + O(h/sup p + 1), where the principal error function e(x) is defined as the solution of another Volterra integro-differential equation. The results of various numerical experiments, including 4th order Runge–Kutta type algorithms, are presented. These experiments serve to confirm the validity of our results. (auth)

5228 FORCELESS MACHIAN DYNAMICS. Barbour, J. B. (College Farm, Oxford). Nuovo Cim.; 26B: No. 1, 16-22(11 Mar 1975).

A model is proposed in which the inertial and gravitational forces of Newtonian mechanics (together with small Machian corrections) are derived from a single simple concept—mass in relative motion. The model provides an example of the forceless dynamics, or dynamics of pure motion, mooted by Hertz. If a velocity that occurs in the model is identified with the velocity of light, the correct order of magnitude of the gravitational constant is predicted. (auth)

5229 TIME DELAY AND PRE-ACCELERATION. Cohn, J. (Univ. of Oklahoma, Norman). Nuovo Cim.; 26B: No. 1, 47-56 (11 Mar 1975).

An alternative to the Lorentz equation (governing radiating electrons) is constructed. The equation is a differential-difference equation of retarded type, containing a constant time delay, and appears to be as compatible with basic assumptions of physics and observational data as that of Lorentz. Further, and most importantly, this equation does not display pre-acceleration effects, and, with a suitable boundary condition, does not contain runaway solutions. The time delay remains to be specified. (auth)

5230 METHODS FOR USING EXPERIMENTAL DATA TO ESTIMATE FUNCTIONS. Yellin, S. (DESY, Hamburg). Nuovo Cim.; 26B: No. 1, 191-219(11 Mar 1975).

This paper serves three purposes: (1) A general method is given by which one may correct for a bias that results when the maximum-likelihood method is used with a sample of finite size. The application to the problem of unfolding an unknown function from experimental data is discussed. (2) A method is given by which one may determine if the data require the existence of structure in an unknown function. This technique unfolds a function from data without parametrizing; i.e., without assuming that the function is a known function with unknown parameters. If, on the other hand, one is able to reliably parametrize an unknown function, but does not know the functional form of the background to the measurement, a method is supplied for making the foreground-background separation without parametrizing the background. (3) A method is given for improving the effective resolution of experimental measurements. This method is a generalization of "bremsstrahlung end-point subtraction," a common technique in high-energy photon physics. (auth)

5231 GENERALIZED NONADIABATIC GAUSSIANS FOR N-PARTICLE SYSTEMS WHERE L = 0, P = +. Almstroem, H. (Royal Inst. of Tech., Stockholm). Nuovo Cim.; 26B: No. 1, 279-294(11 Mar 1975).

For an N-particle system, with the total angular momentum equal to zero and with positive parity, a flexible and "physical" set of functions is introduced. The space part of the functions is of the form $f(n_1, \ldots, n_T; \bar{u}_1, \ldots, \bar{u}_T) = \Pi_{i=1}^{T} L_{n_i}(2u_i^2) \exp[-u_i^2]$, $T \geq N - 1$, where $\bar{u}_i$ is an arbitrary, translation invariant, linear combination of the position co-ordinates $\bar{r}_1, \ldots, \bar{r}_N$. The possibility of choosing the number of co-ordinates $\bar{u}_i$, used in the functions, makes it possible to introduce all distances of importance and hence avoid the introduction of angular co-ordinates. The matrix elements $\phi(n_1, \ldots, n_T; \bar{u}_1, \ldots, \bar{u}_T) \cdot Q_{op} f(n'_1, \ldots, n'_{T'}; \bar{u}'_1, \ldots, \bar{u}'_{T'})$, where Q_{op} stands for $H = -\Sigma_{i=1}^{N}(1/2M_i)\Delta_{\bar{r}_i} + (1/2M_{tot})\Delta_{\bar{r}_{c.m.}} + \Sigma_{1\leq i<j\leq N}\Sigma(Z_iZ_j/|\bar{r}_i - \bar{r}_j|)$ or 1, and where $\bar{u}_i = \Sigma_{j=1}^{N} a_{ij}\bar{r}_j$, $i = 1, \ldots, T$, $\bar{u}'_i = \Sigma_{j=1}^{N} a'_{ij}\bar{r}_j$, $i = 1, \ldots, T'$, are calculated exactly and given in an easily calculable form. The technique is illustrated on the system HD^+. (auth)

5232 DYNAMICAL SYMMETRIES AND THE NONCONSERVATIVE CLASSICAL SYSTEM. Buch, L.H.; Denman, H.H. (Department of Physics, Wayne State University, Detroit, Michigan 48202). Phys. Rev. D 11: No. 2, 279-281 (15 Jan 1975).

All 3-dimensional, time-dependent classical Hamiltonian systems are shown to possess the dynamical symmetries SU_3 and O_4. As an example, the Newtonian, linearly damped, isotropic harmonic oscillator in a time-dependent external field is treated. (auth)

5233 EXISTENCE THEOREM FOR A BACKWARDS TWO-BODY PROBLEM OF ELECTRODYNAMICS. Travis, S.P. (Naval Underwater Systems Center, Newport, Rhode Island 02840). Phys. Rev. D 11: No. 2, 292-299 (15 Jan 1975).

The equations of motion for two charged particles moving in one dimension form a system of functional and delay differential equations, based on the Liénard-Wiechert potentials. For the case of retarded potentials only, Synge has suggested a method of successive approximations for proving that specifying initial positions and velocities will determine the entire past histories of the particles. Driver has shown that such Newtonian initial data generally do not uniquely define solutions to delay differential equations. But he does prove an existence and uniqueness result for particles with like charges when certain

constraints are placed on the initial data. Here the recommended method of Synge is used to prove an existence result for initial data which includes some cases not meeting the requirements demanded by Driver. (auth)

5234 NONPERTURBATIVE PATH-INTEGRAL APPROXIMATIONS. Reiss, H.R. (Physics Department, The American University, Washington, D.C. 20016). Phys. Rev. D 11: No. 2, 388-394 (15 Jan 1975).

A nonperturbative path-integral approximation scheme is introduced heuristically, and then interpreted from the point of view of Feynman path integrals. The utility and the properties of the technique are explored by application to three widely different problems. When applied to the problem of a bound charged particle in an electromagnetic field, the method yields the momentum-translation approximation plus corrections. For high-energy scattering, the technique gives immediately the standard eikonal results, and also suggests corrections. For a charged free particle in an electromagnetic field, the method in simplest form leads to an approximation to the exact Volkov solution, and correction terms yield precisely the Vólkov solution. (auth)

5235 SEMICLASSICAL LIMIT OF MULTICHANNEL SCATTERING THEORY. Laing, J.R.; Freed, K.F. (The James Franck Institute and The Department of Chemistry, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. Lett. 34: No. 14, 849-852 (7 Apr 1975).

The space-time propagator for multichannel scattering is cast in the form of a Feynman path integral where the action is a matrix and the interactions are nonlocal in time. The S matrix is evaluated in the semiclassical limit, leading to trajectories which naturally follow individual channel potentials in noninteracting regions and adiabatic-like ones in strongly interacting ones. A numerical example is provided for the curve-crossing problem, and the agreement with exact quantum results is good even when the interaction region is large and/or encompasses classical turning points. (auth)

5236 RELATIVISTIC RELAXATION-TIME MODEL WITH APPLICATIONS TO TRANSPORT COEFFICIENTS. Witting, H. R. Hoboken, NJ; Stevens Inst. of Tech. (1974). 95p. University Microfilms Order No. 75-2818.

Thesis (Ph. D.).

A relaxation-time model is proposed for the collision term of the relativistic Boltzmann equation for a single component gas. The resulting equation is solved as a power series in the relaxation-time and this solution is used to calculate the transport coefficients for the gas. The coefficients for a single component Maxwell-Boltzmann gas are compared with those obtained using the relativistic Grad moment method and Marle's version of the relativistic relaxation-time model. The results indicate that the proposed relaxation-time model gives values for the transport coefficients which agree with the values obtained using the relativistic Grad moment method. The transport coefficients for single component quantum gases are then calculated. (Diss. Abstr. Int., B)

5237 IS THE HILBERT SPACE LANGUAGE TOO RICH? Kupczynski, M. (International Centre for Theoretical Physics, Trieste, Italy). Int. J. Theor. Phys.; 10: No. 5, 297-316(Sep 1974).

In order to answer this question, different phenomena occurring in general experimental set-ups arranged to analyze the properties of some unknown beams of particles are analyzed. It is concluded that sometimes the Hilbert space language appears to be too rich and also that there are some phenomena where the notion of transition probability disappears, and any attempt to introduce it leads to the possibility of infinitely many inequivalent descriptions. The analysis encouraged the question whether the Hilbert space language is not too rich in the more realistic situations, for example to deal with high energy elementary particle scattering phenomena. A program of investigations in that direction is formulated. In the polemic with axiomatic quantum mechanics it is shown that the pure state concept can be formulated independently of the existence of any maximal filter. (auth)

5238 DISCRETE SPECTRUM OF SOLUTIONS OF THE WAVE EQUATION WITH STRONG CUBIC NONLINEARITY. Bishopp, F. (Brown Univ., Providence). Int. J. Theor. Phys.; 11: No. 1, 5-29(Oct 1974).

The nonlinear wave equation, $\phi_{tt} - \Delta\phi + \phi^3 = 0$, has many solutions that are periodic in time and localized in space, all with infinite energies. The search for spherically symmetric solutions that are well represented by the simple approximation, $\phi(r,t) \equiv A(r)\sin\omega t$, leads to a discrete spectrum of solutions $\{\phi_N(r,t;\omega)\}$. The solutions are nonlinear wave packets, and they can be regarded as particles. The asymptotic theory ($\omega \to \infty$) of the motion of the guiding center of the Nth wave packet, in the presence of a specified potential, is characterized by an infinite mechanical mass and an infinite interaction mass, and they are compatible. The rest mass in the classical relativistic mechanics of guiding centers is $m_0c^2 = \hbar_N\omega$; i.e., the spectrum $\{\phi_N\}$ determines a spectrum of Planck's constants. (auth)

5239 ORTHONORMAL TETRAD TRANSPORT. II. Physical Identification of the Normals and Curvatures of a Time-Like Curve. Krause, J. (Univ. Catolica de Chile, Santiago). Int. J. Theor. Phys.; 11: No, 4. 273-284(Nov 1974).

A flat space-time time-like curve is considered from the point of view of an instantaneous comoving inertial observer. In the context of the "vierbein" formalism a projection operator is introduced, able to project 3-vectors, belonging to the 3-space of the comoving observer, out of space-time 4-vectors. The motion of an accelerated particle relative to the comoving inertial frame is briefly reviewed by means of the projection technique, and the three space-like components of the Frenet-Serret tetrad are thus projected, and their motion relative to the comoving observer neatly stated. Finally, the physical identification of the normals and the curvatures is obtained in terms of three-dimensional kinematics as seen by the instantaneous comoving observer. (auth)

5240 CAYLEY PARAMETRIZATION OF SEMISIMPLE LIE GROUPS AND ITS APPLICATION TO PHYSICAL LAWS IN A (3 + 1)-DIMENSIONAL CUBIC LATTICE. Lorente, M. (Boston Univ.). Int. J. Theor. Phys.; 11: No. 4, 213-247(Nov 1974).

From conference on dynamical groups; Boston, MA (May 1973).

The assumption of a discrete space-time is expressed mathematically by restricting the space-time variables to the field of integer numbers, and by restricting to the field of rational numbers the functions describing the laws of motion. This rational character must be preserved under the transformations connecting different systems of reference. The Cayley parametrization of semisimple Lie groups, and in particular of the Lorentz group, satisfies this condition if it is required that these parameters take only integer values. The rational points of the most frequently used transcendental functions are obtained with the help of the integer complex and hypercomplex numbers. Some applications are made concerning the laws of motion in special relativity defined over a (3 + 1)-dimensional cubic lattice. (auth)

5241 ACTION PRINCIPLE IN QUANTUM MECHANICS. Cohen, H. A.; Shaharir, M. Z. (La Trobe Univ., Bundoora, Australia). Int. J. Theor. Phys.; 11: No. 5, 289-303(Dec 1974).

The Euler-Lagrange equation derived from Schwinger's action principle (Phys. Rev.; 82: 914(1951)) was shown by Kiang et al., (Phys. Rev.; 181: 1380(1969)) and Lin et al., (Nuclear Phys.; B16: 431(1970)) to lead to inconsistencies for quadratic lagrangians of the form $\mathrm{L}(\dot{q},q) = \frac{1}{2}\dot{q}^j g_{jk}(q)\dot{q}^k - V(q)$ except in the Euclidean case $g_{jk} = \delta_{jk}$. This inadequacy is linked to Schwinger's specification that the variations of operators be c-numbers. The action principle is reformulated by introducing the concept of "proper" Gauteaux variation of operators to find the most general class of admissible variation consistent with the postulated quantization rules. This new action principle, applied to the Lagrangian L, yields a quantum Euler equation consistent with the Hamilton-Heisenberg equations. (auth)

5242 A LEAST-SQUARES SPECTRAL CURVE FITTING ROUTINE FOR STRONGLY OVERLAPPING LORENTZIANS OR GAUSSIANS. von Meerwall, E. (The University of Akron, Akron, Ohio 44325, USA). Comput. Phys. Commun.; 9: No. 2, 117-128(Feb 1975).

A program is described for fitting a background level plus or minus the sum of a number of Lorentzian or Gaussian lineshapes to experimental spectra, honoring linear constraints between arbitrary pairs of parameters. A non-linear variable metric minimization technique is used iteratively to optimize the parameters of the theoretical function by minimizing χ^2 for the spectral data. (auth)

5243 ELECTROMAGNETIC STRESS AND MOMENTUM IN MATTER. Robinson, F. N. H. (Bell Labs., Holmdel, N. J. (USA)). Phys. Rep.; 16: No. 6, 313-354(Mar 1975).

Whether the momentum density associated with an electromagnetic wave in a refracting medium is solely determined by its intensity or is dependent on the refractive index is perhaps of little practical importance, and probably beyond the power of present experimental techniques to decide. Nevertheless, since this question was first propounded by Abraham and Minkowski, it has continued to attract physicists' attention and, to judge by current literature, is still regarded as an open and quite possibly insoluble question. This article expounds some of the approaches to its solution that have been proposed, and shows that one of them leads to a complete solution of both the Abraham-Minkowski controversy and the more general problem of describing the distribution of stress in a material medium in the presence of an electromagnetic disturbance. The treatment

emphasizes the significance of the electrostrictive and magnetostrictive terms in the stress tensor. These relatively unfamiliar effects are neither small nor unimportant. They express, in macroscopic terms, consequences of the microscopic structure of a medium which are not adequately described by the usual constitutive relations involving only the relative dielectric constant and the relative magnetic permeability. Their presence in the macroscopic theory ultimately reflects the fact that the individual microscopic charges in matter are subject to forces which, though purely electromagnetic, cannot adequately be described in terms of macroscopic fields, even if these fields are modified by the inclusion of a Lorentz local-field correction. As a result they form a crucial link in the connection between macroscopic treatments. (auth)

5244 KINEMATIC FITTING: AN IMPROVED METHOD FOR CONVERGENCE. Crennell, D. J.; Hall, D. E. (SEE CODE-5677710 Science Research Council, Chilton (UK). Rutherford High Energy Lab.). Comput. Phys. Commun.; 9: No. 2, 79-84 (Feb 1975).

A brief description of the method of calculating and using the second derivatives of the constraints is given after an introduction to the standard problem and its solution. Results are presented showing the increased efficiency of the method and how previously rejected events are physically biased. (auth)

5245 STATISTICAL THERMODYNAMIC GENERALIZATION OF THE HELLMANN–FEYNMAN AND QUANTUM MECHANICAL CURVATURE THEOREMS. Golden, S. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotopes). Chem. Phys. Lett.; 31: No. 1, 195-197(15 Feb 1975).

The statistical thermodynamic analogs and generalization of the Hellmann–Feynman theorem and the quantum mechanical curvature theorem of Silverman and van Leuven are derived for Hamiltonians of the form $\Sigma_{m=1}^{M} P_m H P_m$, the P's forming a complete set of mutually orthogonal and parametrically-dependent projections which maximize the associated partition functions. (auth)

Quantum Field Theories

Refer also to abstracts 4447, 4622, 4626, 4649, 4670, 4671, 4688, 4731, 4734, 5131, and 5277.

5246 (IC-74-12) RENORMALIZATION GROUP REPRESENTATION AND THE GELL-MANN–LOW AND CALLAN–SYMANZIK EQUATIONS. Jouvet, B. (International Centre for Theoretical Physics, Trieste (Italy)). Feb 1974. 40p. INIS.

Admitting that the photon propagator is a representation of the renormalization group, it is first determined which specific property of QED is implied by the existence of the G-M-L and C-S equations in perturbation theory. After elucidating the different roles played by the G-M-L and C-S functions, ψ and β, in the determination of the photon propagator, are indicated conditions under which $\beta(\alpha)$ is or not related to its asymptotic behavior. Taking a global point of view, it is shown, that the nullity of the second member of the C-S equation at infinity is implied by unitarity, except in one special case. The global expression of $\beta(\alpha)$ leads to classify the photon propagators into two different classes. In the first, the G-M-L equation gives a faithful representation of their asymptotic behavior. In the second, which is studied in detail, the bare charge is a function of α, $\beta(\alpha) = 0$, and the perturbation theory determines fallacious β and ψ functions. (auth)

5247 (JINR-E2-8449) RENORMALIZATION OF SUPERSYMMETRIC GAUGE THEORIES. II. Nonabelian Case. Slavnov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. Dep. NTIS (US Sales Only) $4.00.

A manifestly invariant renormalization procedure is formulated for the supersymmetric non-abelian gauge theories. All ultraviolet infinities are shown to be eliminated by a common wave function and charge renormalization. (auth)

5248 (JINR-E2-8600) SCATTERING OF COMPOSITE PARTICLES AND QUASIPOTENTIAL APPROACH IN QUANTUM FIELD THEORY. Faustov, R. N.; Garsevanishvili, V. R.; Kvinikhidze, A. N.; Matveev, V. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

Scattering of composite particles is considered on the basis of the "light-front" form of the quasipotential approach in quantum field theory. (auth)

5249 (JINR-E2-8649) APPLICATION OF 't HOOFT'S RENORMALIZATION SCHEME TO TWO-LOOP CALCULATIONS. Vladimirov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 20p. Dep. NTIS (US Sales Only) $4.00.

The manifest advantages of 't Hooft's scheme for the asymptotic calculations are demonstrated. The two-loop computations are carried out in three particular models: scalar electrodynamics, pseudoscalar Yukawa theory, and supersymmetric model by Wess and Zumino. (auth)

5250 (JINR-E2-8650) RENORMALIZATION GROUP EQUATIONS IN DIFFERENT APPROACHES. Vladimirov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

Renormalization group equations for the nonnormalized Green functions and invariant charges are presented. The equivalence of different renormalization schemes is used to derive the relations between the renormalization group functions of these schemes. A simple way to carry out the renormalization group computations is outlined. (auth)

5251 (JINR-P2-8418) QUANTIZATION OF ELECTROMAGNETIC FIELD IN THE STATIC SPHERICAL WORLD. Pestov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The Maxwell equations in the static spherical world are solved using separation of variables. Eigenvectors and eigenvalues of the polarization operator are found. A complete countable set of the creation and annihilation operators of photons is obtained. (auth)

5252 SPINOR SUPERFIELD AND BOSE–FERMI SYMMETRY. Adjei, S. A.; Akyeampong, D. A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 26A: No. 1, 84-93 (1 Mar 1975).

If one uses the superspace techniques of Salam and Strathdee, a new supersymmetric Lagrangian involving Dirac and Duffin-Kemmer component fields is obtained. A simple interaction Lagrangian of this spinor superfield with the scalar superfield is studied in perturbation theory, where it is shown that although the Lagrangian is not renormalizable at the 1-loop level, remarkable cancellations of divergences occur leaving only logarithmic and quadratic infinities. (auth)

5253 FERMION NUMBER AND ITS CONSERVATION. Pati, J. C. (Univ. of Maryland, College Park); Salam, A.; Strathdee, J. Nuovo Cim.; 26A: No. 1, 72-83(1 Mar 1975).

The question is raised if the fermion number (F = B + L) is absolutely conserved. Neutrinoless double-β-decay experiments give upper limits on $|\Delta L| = 2$ transitions. Experiments on the stability of the deuteron against decay into pions would give analogous limits on $|\Delta B| = 6$ transitions, while proton stability experiments set limits on $|\Delta F| = 0$, $\Delta B = -\Delta L$ as well as on transitions involving $|\Delta F| \neq 0$. Here B = +1 for (integer or zero charge) quarks, B = −1 for antiquarks, while L is the lepton number. Remarking that the maximal symmetry group for the kinematic-energy terms of a set of n four-component Dirac fields is SU_{2n} rather than $U_1 \times SU_{Ln} \times SU_{Rn}$ (with the extra gauge currents carrying fermion number ±2), the possibility of constructing spontaneously broken gauge theories where the fermion number appears as a non-Abelian generator is briefly investigated. (auth)

5254 SCALAR EXTENSION OF THE NEW THEORY OF GRAVITATION. Yilmaz, H. (Perception Tech., Winchester, MA). Nuovo Cim.; 26B: No. 1, 165-170(11 Mar 1975).

The new theory of gravitation proposed by the author is extendable to accommodate a cosmic field of Dicke-Brans type. It is shown that the predictions are the same as those of the usual Dicke-Brans theory but the cosmic field is not necessarily interpretable as a pure scalar. (auth)

5255 WEYL'S GAUGE FIELD. Utiyama, R. (Osaka Univ.). Gen. Relativity Gravitation; 6: No. 1, 41-47(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (June 1974).

A new scalar field, called a measure field, is proposed which plays a role of measure assigned to each world point. By measuring all the quantities with a standard given by the above mentioned measure field, it is shown to be possible to write all the field equations in a manifestly gauge-invariant manner. Weyl's gauge field, when it is written in this fashion, is proved to have a negative energy density and has a tachyon-like property inside material particles. It is shown, however, that such a strange field cannot come out of the matter. (auth)

5256 AN EXPLICIT MODEL FOR THE RENORMALIZATION OF FIELD EQUATIONS. de Mottoni, P.; Tesei, A. (G.N.A.F.A.,

C.N.R., Roma, Italy). J. Math. Phys. (N.Y.) 16: No. 5, 1148-1149 (May 1975).

We provide a simple model where a procedure for renormalizing field equations yields nontrivial distribution solutions. (auth)

5257 QUANTUM-BEAT PHENOMENA DESCRIBED BY QUANTUM ELECTRODYNAMICS AND NEOCLASSICAL THEORY. Chow, W.W.; Scully, M.O.; Stoner, J.O. Jr. (Department of Physics and Optical Sciences Center, University of Arizona, Tucson, Arizona 85721). Phys. Rev. A 11: No. 4, 1380-1388 (Apr 1975).

We propose and analyze the use of quantum-beat phenomena to test neoclassical radiation theory (NCT) and quantum electrodynamics (QED). For a beam-foil type of experiment with atoms having one upper level and two closely spaced lower levels, all coherently excited, NCT predicts the presence of quantum beats in the emitted radiation; beats are not expected in QED. QED predicts beats when many atoms are present, in agreement with recent photon-echo experiments. An experiment to test NCT and QED is suggested. (auth)

5258 BOUND-STATE WAVE FUNCTIONS AND BOUND-STATE SCATTERING IN RELATIVISTIC FIELD THEORY. Huang, K.; Weldon, H.A. (Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 11: No. 2, 257-278 (15 Jan 1975).

We describe how a matrix element of an operator may be calculated between bound states, in the framework of conventional relativistic field theory. In the course of doing so, we examine how bound-state creation and annihilation operators may be constructed, the asymptotic condition for bound states, what general types of wave functions are appropriate for describing bound states and why, graphical analysis involving bound states, and questions of renormalizability. The final result is a set of Feynman-type rules for calculating a matrix element. Those for the S matrix are stated explicitly. (auth)

5259 SOURCE-THEORY INVESTIGATION OF PARTICLE-PARTICLE SCATTERING IN SCALAR ELECTRODYNAMICS. DeRaad, L.L. Jr. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 11: No. 2, 282-291 (15 Jan 1975).

We explicitly calculate the fourth-order particle-particle scattering amplitude in scalar electrodynamics using the techniques of source theory. We find that there is an ambiguity in determining the space-time extrapolation of the resulting spectral forms which necessitates the introduction of a local ϕ^4 coupling. There is then a new experimental number necessary in addition to the electric charge. Some consequences of the new interaction are considered which imply that an arbitrary coupling constant will not lead to further ambiguities. Therefore, scalar electrodynamics is generally a two-parameter theory. There is one exception in that a consistent one-parameter theory is possible for which the additional local coupling is zero. (auth)

5260 BOSE CONDENSATION IN SUPERCRITICAL EXTERNAL FIELDS. Klein, A.; Rafelski, J. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. D 11: No. 2, 300-311 (15 Jan 1975).

We study the relativistic field theory of a charged spin-zero boson field in the presence of an external field, such as the Coulomb field of a prescribed charge distribution. It is shown that for a sufficiently intense field the ground state is unstable against the formation of a Bose-Einstein condensate of charged boson pairs. A consistent quantum theory can be formulated when known nonlinear couplings such as the Coulomb interactions of the bosons are properly included in the Hamiltonian. Speculations are offered concerning the possible stability of nuclei with charge number $Z \gtrsim 10^3$. (auth)

5261 FINITE YANG-MILLS THEORIES AND THE BJORKEN-JOHNSON-LOW LIMIT. Ali, A. (The Stevens Institute of Technology, Hoboken, New Jersey 07030 and Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305); Bernstein, J. Phys. Rev. D 11: No. 2, 336-340 (15 Jan 1975).

We consider the Bjorken-Johnson-Low limit for the propagator in massless Yang-Mills theories. The significance of our result in terms of imposing an eigenvalue on the theory so as to render it finite is discussed. (auth)

5262 BLOOM-GILMAN DUALITY IN RENORMALIZABLE FIELD THEORY. Shei, S. (Department of Physics, Rockefeller University, New York, New York 10021. Phys. Rev. D 11: No. 2, 341-347 (15 Jan 1975).

We study the validity of Bloom-Gilman duality in renormalizable field theory. It is found that, in pseudoscalar theory and neutral vector-gluon theory, Bloom-Gilman duality is in general violated. We also discuss whether the leading-logarithmic approximation is the cause of the breakdown of Bloom-Gilman duality. (auth)

5263 COMMENT ON GENERALIZED EULER-POCHHAMMER INTEGRAL REPRESENTATION FOR SINGLE-LOOP FEYNMAN AMPLITUDES. Mano, K. (Air Force Cambridge Research Laboratories, Bedford, Massachusetts 01730). Phys. Rev. D 11: No. 2, 452-454 (15 Jan 1975).

Use of the F_D function of Lauricella is suggested in obtaining the Euler-Pochhammer-type integral representation for the single-loop Feynman amplitude of arbitrary order. It is shown that the F_D function is naturally suited in that it leads to a recurrence relation for the amplitude under consideration. (auth)

5264 QUANTIZED "SINE-GORDON" EQUATION WITH A NONVANISHING MASS TERM IN TWO SPACE-TIME DIMENSIONS. Fröhlich, J. (Department of Mathematics, Princeton University, Princeton, New Jersey 08540). Phys. Rev. Lett. 34: No. 13, 833-836 (31 Mar 1975).

For $\epsilon^2 < 4\pi$ the $\lambda \sin(\epsilon\Phi + \theta)$ quantum field model corresponding to the "sine-Gordon" equation with a nonvanishing mass term in two space-time dimensions exists and yields a field theory satisfying the Wightman axioms. For $|\lambda|$ small enough, the Euclidean Green's functions of this model have a convergent Feynman perturbation series. For λ large enough and positive, ϵ positive, and $\theta = 0$, the $\Phi \to -\Phi$ symmetry is presumably dynamically broken. (auth)

5265 ON THE INFRARED SINGULARITIES OF GREEN'S FUNCTIONS IN QUANTUM ELECTRODYNAMICS. Papanicolaou, N. (Department of Physics, New York University, New York, N. Y. 10003). Ann. Phys. (N.Y.) 89: No. 2, 423-440 (Feb 1975).

We present a formal calculation of the infrared singularity structure of the fermion propagator QED based on the Faddeev-Kulish asymptotic solution. The Renormalization program is reviewed in the context of the BPHZ subtraction scheme and a refinement of the Renormalization group methods is employed to study the infrared singularities in perturbation theory. (auth)

5266 WHAT WE CAN LEARN ABOUT QUANTUM ELECTRODYNAMICS FROM HEAVY ION COLLISIONS. Rafelski, J.; Klein, A. (Univ. of Pennsylvania, Philadelphia). pp 397-415 of Proceedings of the International Conference on Reactions Between Complex Nuclei. Vol. 2. Robinson, R. L. (ed.). New York; American Elsevier Publishing Co., Inc. (1974).

From international conference on reactions between complex nuclei; Nashville, Tennessee, USA (10 Jun 1974). See CONF-740637-P2.

The great success of quantum electrodynamics carries with it the importance of finding the limits of validity for the theory. A heavy-ion beam can be used to test some of these limits. Questions connected with the experimental proof of the instability of the neutral vacuum in supercritical fields and its decays into charged vacuum by means of positron emission are reviewed. The measurement of vacuum polarization in heavy-ion scattering is also discussed. (14 figures) (RWR)

5267 SPECTRUM AND THE LAMB SHIFT OF HELIUM FROM A SELF-CONSISTENT FIELD THEORY OF ELEMENTARY MATTER. Yu, H. Buffalo; State Univ. of New York (1974). 73p. University Microfilms Order No. 75-7819.

Thesis (Ph. D.).

The results of an investigation of the finite self-consistent field theory of elementary matter applied earlier to the calculation of the Lamb shift in hydrogen, now applied to the problem of the Lamb shift in the low lying states of helium is presented. The covariant nonlinear field equations of this theory for helium are constructed from the Lagrangian formalism. In the linear approximation, the Hamiltonian associated with the theory for helium atom is set up. It is equivalent to the Breit Hamiltonian plus two extra terms. This generalization is a direct consequence of two-component spinor formalism of electromagnetism that is contained in this field theory. Thus, the energy spectrum predicted for the helium atom is the spectrum predicted by the Breit Hamiltonian, shifted by amounts in the different states due to the effects of these extra terms. The later can be associated with the corrections to the helium spectrum that are conventionally attributed to the Lamb shift. The level shift for the ground state and first excited states are calculated using the Foldy-Wouthuysen transformation, with the generalization of Charplvy for the two-electron atom. The results are found to be in close agreement with the experimental values for the energy shifts not predicted by the Dirac theory, and with the theoretical values predicted by quantum electrodynamics. (Diss. Abstr. Int., B)

5268 NATURAL MODE OF QUANTIZATION. Olsen, S. O. (Norwegian Defence Research Establishment, Kjeller). Acta Phys. Acad. Sci. Hung.; 37: No. 1-2, 97-103(1974).

Particles occur as solutions of nonlinear (unitarian) classical field theories. It is suggested that the quantum mechanics of those particles may under certain circumstances be derivable from the nonlinear field equations. A Born–Infeld type equation is studied. $(1 + \varphi_t^2)\varphi_{xx} - 2\varphi_x\varphi_t\varphi_{xt} - (1 - \varphi_x^2)\varphi_{tt} = 0$. By redefining the field strength as $\varphi_t \to \varphi_t + il_0\partial/\partial x$ it is shown that the fourth-order

equation $-l_0^4\varphi_{xxxx} + \varphi_{xx} - \varphi_{tt} = 0$ results, which for high wave numbers $l_0^2k^2 \gg 1$ is equivalent to a Schroedinger equation. (auth)

5269 AXIOMATIC FOUNDATIONS OF THE THEORY OF SPECIAL RELATIVITY. Reply to Stiegler. Podlaha, M. Int. J. Theor. Phys.; 11: No. 1, 69-72(Oct 1974).

Reference is made to an article by Stiegler (Int. J. Theor. Phys.; 5: 403(1972)) in which he referred to the present author's work on the Palacios theory and special relativity. It is pointed out that a very great number of papers on this and related subjects were not mentioned by Stiegler and further that he showed a deep misunderstanding of the Palacios and related transformations with which he dealt. It is considered that there are several possibilities of how to derive or achieve the transformation (S, 3.3.2) (S means Steigler's notation) and although no advantage is seen in the method used by Steigler and no criticism is made of it yet the subsequent errors must be considered. These are discussed. (UK)

5270 CONFORMAL INVARIANCE AND THE SIX-DIMENSIONAL FORMALISM. Sigal, R. F. (Alberta Univ., Edmonton, Canada). Int. J. Theor. Phys.; 11: No. 1, 45-68(Oct 1974).

Conformal invariance is discussed assuming the equations are well defined in arbitrary coordinate systems. This assumption leads to some constraints on scale dimensions of terms, and constraints on the introduction of "conformally invariant massive equations." The six-dimensional formalism is then discussed and is generalized to project to all conformally flat spaces. Finally the imbedding of Minkowski space equations is studied. SO(4,2) breaking is seen to enter due to the presence of a noninvariant scalar field, and a noninvariant vector field. The theorem relating invariance of the six-space equations under SO(4,2) to the invariance of their corresponding four-space equations under the conformal group is carefully stated and proved. (auth)

5271 DIMENSIONAL REGULARIZATION OF INFRARED DIVERGENCES. Marciano, W. J. (Rockefeller Univ., New York (USA)); Sirlin, A. (New York Univ., N. Y. (USA). Dept. of Physics). Nucl. Phys., B; 88: No. 1, 86-98(17 Mar 1975).

An analysis of the application of dimensional regularization to infrared divergences in lowest order radiative corrections is presented. The main emphasis is to show explicitly how dimensional regularization can lead in some cases of considerable interest to very simple and elegant evaluations of infrared divergent contributions and their associated finite parts, and to pinpoint the mathematical reason for the equivalence with the traditional method of regularization. (auth)

5272 ON THE EFFECTIVE POTENTIAL FOR THE SCALAR MULTIPLET IN THE SUPERSYMMETRIC ϕ^3 MODEL. Fujikawa, K.; Lang, W. (Karlsruhe Univ. (TH) (F. R. Germany)). Nucl. Phys., B; 88: No. 1, 77-85(17 Mar 1975).

The one-loop effective potential for the scalar multiplet in the supersymmetric model with a ϕ^3 self-interaction is evaluated, and the vacuum stability is discussed. It is shown that the asymmetric vacua give rise to an imaginary part of the effective potential; consequently they are unstable. The result also indicates that the massless degenerate solution is stable against infrared divergences. (auth)

5273 PERTURBATION CALCULATIONS FOR THE SCALAR MULTIPLET IN A SUPERFIELD FORMULATION. Fujikawa, K.; Lang, W. (Karlsruhe Univ. (TH) (F. R. Germany)). Nucl. Phys., B; 88: No. 1, 61-76(17 Mar 1975).

Based on the superfield propagators for the scalar multiplet, the occurrence of divergence cancellations in supersymmetric models is investigated. This cancellation mechanism is governed by the Ward identity which has an integral form in the present formulation. The power counting rules for the actual divergence of diagrams in the models with a ϕ^3 and a ϕ^4 self-interaction are given. Finally a systematic treatment is presented of the ϕ^4 model up to the two-loop level. The structure of the necessary counter terms is specified and the appearance of negative norm states is indicated. (auth)

5274 ASYMPTOTIC EXPANSION OF FEYNMAN AMPLITUDES. P. 1. The Convergent Case. Bergere, M. C.; Lam, Y. M. P. (Freie Univ. Berlin (F. R. Germany). Inst. fuer Theoretische Physik). Commun. Math. Phys.; 39: No. 1, 1-32 (Nov 1974).

Employing the technique of Mellin transforms to the scalar convergent Feynman amplitude in the Schwinger integral representation, we determine its asymptotic expansion for large Euclidean momenta. The determination of the coefficients of the expansion is effected via the use generalized Taylor operators. (auth)

5275 REARRANGEMENT OF FEYNMAN RULES AND RENORMALIZABILITY OF MASSIVE VECTOR FIELDS. Shizuya, K. (Tokyo Univ. (Japan). Dept. of Physics). Nucl. Phys., B; 87: No. 2, 255-268(3 Mar 1975).

A general procedure is presented for recasting a set of Feynman rules of vector field theories into another set by use of functional integration techniques. This procedure, when applied to the neutral vector meson coupled to a conserved current, allows one to recast conventional Feynman rules into the ones of arbitrary (even nonlinear) gauges, and reveals the fact that this theory is manifestly renormalizable in any covariant (nonlinear) gauges. Likewise, the massive Yang-Mills theory can be converted into the one with a generalized Feynman gauge-like constraint, and it is then shown that the massive Yang–Mills field is not renormalizable. (auth)

5276 REGGE BEHAVIOR UNDER ASYMPTOTIC FREEDOM. Lovelace, C. (Rutgers–the State Univ., New Brunswick, N. J. (USA). Dept. of Physics). Phys. Lett., B; 55: No. 2, 187-191 (3 Feb 1975).

By a new method, it is shown that the asymptotically free ϕ_4^3 field theory has a point of accumulation of Regge poles but no fixed cut. It is plausible that nonabelian gauge theories have an analogous singularity at $j = 1$. (auth)

Gravitation and General Relativity

Refer also to abstracts 4361, 4366, and 4656.

5277 (JINR-E2-8636) CANONICAL FIELD QUANTIZATION IN AN EXTERNAL TIME-DEPENDENT GRAVITATIONAL FIELD: RESTRICTIONS FROM THE GENERAL PROPERTIES OF FEYNMAN PROPAGATOR. Il'in, S. B.; Tagirov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 27p. Dep. NTIS (US Sales Only) $4.50.

The Green functions of the quantum scalar field interacting with gravitation of the homogeneous isotropic closed universe are studied. They were determined as an expectation value of the time-ordered product of two field operators in the cyclic states of various, in general, unitary-nonequivalent representations of canonical commutation relations. The regularity properties of these functions are shown to be the same as of the Feynman propagator obtained in previously for arbitrary Riemannian space-time only in the representations that form a class of unitary equivalence. (auth)

5278 GEOMETRODYNAMICS AND SPIN. Kiehn, R. M. (Univ. of Houston). Lett. Nuovo Cim.; 12: No. 9, 300-302(1 Mar 1975).

Following the presentation of a simple geometric topological model for spin a theory which fits the ideas into the differential-geometry base of geometrodynamics is discussed. The Gauss–Weingarten theory is mainly considered. (JFP)

5279 CHRONOS PRINCIPLE. Christodoulou, D. (CERN, Geneva). Nuovo Cim.; 26B: No. 1, 67-93(11 Mar 1975).

The definition of time is established as a fundamental physical principle. From this principle, in connection with the quantum and relativity principles, the laws of quantum geometrodynamics and, in the classical limit, those of general relativity theory, are uniquely deduced. (auth)

5280 TEST PARTICLES IN THE FIELD OF A SPINNING NAKED SINGULARITY. de Felice, F.; Calvani, M.; Nobili, L. (Gruppo di Astrofisica Teorica, Padua). Nuovo Cim.; 26B: No. 1, 1-15(11 Mar 1975).

The geodesic properties of a spinning naked singularity are analysed to achieve a better understanding about its nature. Repulsive phenomena are shown to exist and are interpreted in a way which preserves the attractive character of gravitation. (auth)

5281 EINSTEIN AND NEWTON'S THEORIES WITHIN THE SAME FORMULATION OF THE GRAVITATIONAL FIELD. Goded, F. (Escuela Tecnica Superior de Ingenieros Industriales, Madrid). Gen. Relativity Gravitation; 6: No. 1, 115-118(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

A formulation is indicated in which the gravitational field is assumed to be described by the set of equations $T^{\mu\nu}|_\nu = 0$, $^*T^{\mu\nu}|_\nu = 0$ and $R_{\mu\nu} = 0$ (where the antisymmetric tensor $T_{\mu\nu}$ represents the inverse square forces of Newtonian theory). It is shown that this formulation of the gravitational field includes both the Einstein and the Newtonian theories. (UK)

5282 AXIALLY-SYMMETRIC TWO-BODY PROBLEM. Cooperstock, F. I. (Victoria Univ., B. C.). Gen. Relativity Gravitation; 6: No. 1, 91-97(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

A new approach to the two-body problem is introduced which entails the perturbation of an initially static configuration. It is demonstrated that Einstein's theory demands that the bodies move when the equilibrium-sustaining stress is weakened. Radiation from the system, both during the stress-breaking and free-fall period are discussed. For free-fall, the nonlinearities could greatly alter the energy loss rate from that predicted by the "quadrupole formula". (auth)

5283 GRAVITATIONAL DYNAMICS. Puliafito, S. (Univ. Tecnological Nacional, Mendoza, Argentina). Gen. Relativity Gravitation; 6: No. 1, 79-90(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

This conception is mainly based on the identity principle of mass, but centered on a purely gravitational basis. Its main feature seems to be the leading role played by gravitation in every type of physical interaction. Under this conception a reasonable physical description of photons and a theory about the nature of nuclear forces may be obtained. Basic quantum relativistic aspects of gravitational dynamics are analyzed, giving finally a justification of what is called the "wave nature of matter." (auth)

5284 SECOND-ORDER GRAVITATIONAL REDSHIFT. Jaffe, J.; Vessot, R. F. C. (Boston Coll., Chestnut Hill, MA). Gen. Relativity Gravitation; 6: No. 1, 55-61(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

It now appears possible that another distinct test of the second-order term of general relativity may be feasible, through the use of very stable atomic clocks. This experiment, which would measure the second-order gravitational redshift, is a bona fide test of the field equations of gravity, not just a test of the underlying principle of equivalence. (auth)

5285 INERTIA AND GRAVITY: A NEW FORMULATION OF GENERAL RELATIVITY. Quale, A. (Univ. of Oslo). Gen. Relativity Gravitation; 6: No. 1, 63-66(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

A lecture is reported based on a previously published paper (Quale. Fortschr. Phys.; 21: 265-325). The formalism and techniques of classical field theory provide a unified framework for the description of nongravitational fields and their interactions in special relativity. However when one tries to apply these methods to the gravitational field in GR difficulties arise due to the fact that no fixed geometric background exists in the conventional formulation of GR where the spacetime geometry is itself a dynamical object. To reformulate GR in such a way as to reintroduce background geometry it is possible to describe all physical (matter and/or gravitational) quantities on this background. It takes the form of a split, $g_{ik}(x) = \gamma_{ik}(x) + h_{ik}(x)$, gravitation = inertia + gravity, of the Riemannian metric g_{ik} of standard GR into a fixed metric γ_{ik} and a symmetric tensor h_{ik}. By plugging the split into all the standard equations of GR and referring all physical quantities (matter fields μ plus the gravity field h) to the geometric background space with metric γ (γ-space), leads to reformulation of GR. Features of the reformulation are mentioned. (UK)

5286 NEW GENERAL COVARIANT APPROACH TO THE GENERAL RELATIVISTIC TWO-BODY PROBLEM. Rosenblum, A. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Gen. Relativity Gravitation; 6: No. 1, 67-70(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

Approaches by various previous work to the two-body problem in Einstein's theory of gravitation are discussed. A possible objection to the approach of Havas and Goldberg (Phys. Rev.; 128: 3981 (1962)) who gave a consistent method of approximation to determine the field equations and equations of motion at each order using weak field expansion is that the equations are formally Lorentz covariant, and do not transform like tensors in each order of the approximation procedure. A new fast motion approximation (Havas and Rosenblum. Phys. Rev. (in press)) is discussed which differs from that of Havas and Goldberg in that parametrization of the particles is defined in terms of the approximated geometry, with the result that the approximate equations transform like tensors in each order of the approximation procedures. The resulting equations of motion which are consistent with the field equation in the first nontrivial approximation are given. (UK)

5287 LOCAL ISOMETRIC EMBEDDING OF RIEMANNIAN MANIFOLDS WITH GROUPS OF MOTION. Goenner, H. (Univ., Goettingen, Ger.). Gen. Relativity Gravitation; 6: No. 1, 75-78 (Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

One of the methods for a study of the geometrical properties of space-time V_4 consists in regarding it, locally, as a subspace of a flat space E_N of $N \leq 10$ dimensions. The number $p = N - 4 \leq 6$ is called the (embedding) class; it is an arithmetic invariant of space-time. If y^A (A = 1,2, . . ., N) are the coordinates of the single chart in the atlas covering E_N and x^α (α = 1,2,3,4) coordinates of V_n, the local and isometric embedding is described by $y^A = y^A(x^\alpha)$, $g_{\alpha\beta} = \eta_{AB} y^A{}_{,\alpha} y^B{}_{,\beta}$, where $g_{\alpha\beta}$ and η_{AB}: $= e_A \delta_{AB}$, $e_A^2 = 1$ are the components of the metric tensors of V_n and E_N, respectively. Factors for the determination of the embedding class, groups of motion and the embedding class, and Einstein's field equations and class, are discussed. (UK)

5288 GRAVITATIONAL SPIN-SPIN FORCE. Jaffe, J. (Boston Coll., Chestnut Hill, MA). Gen. Relativity Graviation; 6: No. 1, 49-53(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

The gravitational spin-spin interaction between two rotating mass rings is derived in a very simple manner, by the use of an electromagnetic analogy. The feasibility of undertaking a gravitational spin-spin experiment in a laboratory is considered, and it is concluded that the effect is too small to be accurately determined. (auth)

5289 MEANING OF A NON-RENORMALIZABLE THEORY OF GRAVITATION. Klauder, J. R. (Bell Telephone Labs., Inc., Murray Hill, NJ). Gen. Relativity Gravitation; 6: No. 1, 13-19 (Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

The renormalizability of quantum gravity remains an open question while it has been established recently that quantum gravity in the presence of standard sources is nonrenormalizable. In view of traditional confusion and ambiguities surrounding nonrenormalizable quantum field theories, it was felt that physical theories must be renormalizable. Recently a new, nonperturbative view of nonrenormalizable theories was suggested that may have relevance for various interactions including gravity and various sources. In a path integral approach to quantum field theory such a view attributes "hard cores" in the space of field histories to nonrenormalizable interactions. Just as with more familiar "hard cores", turning off the interaction does not completely remove all effects of the potential. Consequently the interacting theory is not even continuously connected to the usual free theory, but rather to an alternative "pseudo-free" theory that incorporates the vestiges of the "hard cores". Some insight into what is the significance and interpretation of nonrenormalizable interactions can be gleaned from exactly soluble models. Application of this philosophy of nonrenormalizable interactions is discussed for the gravitational field in interaction with some standard sources. (auth)

5290 GENERAL RELATIVITY, COLLAPSE, AND SINGULARITIES. Wheeler, J. A. (Princeton Univ., NJ). pp 519-571 of High Energy Astrophysics and Its Relation to Elementary Particle Physics. Brecher, K. (ed.). Cambridge, MA; Massachusetts Inst. of Tech. Press (1974).

From conference on high energy astrophysics and its relation to elementary particle physics; Erice, Italy (16 Jun 1972). See CONF-7206108-.

The lectures on general relativity, collapse, and singularities include gravitational collapse and black hole physics, structure without structure of gravitational collapse, and dynamics of a particle in geometry. (JFP)

5291 ROTATING FRAMES IN SPECIAL RELATIVITY. Strauss, M. Int. J. Theor. Phys.; 11: No. 2, 107-123(Oct 1974).

A uniformly rotating frame is defined as the rest frame of a particle revolving with constant velocity ω in a circle about the Z-axis of an inertial frame Σ^0. Under the condition z = Z, r = R, theoretical constraints are established for the solution of the transformation problem $\Sigma^0 \to \Sigma^\omega_r$, Σ^ω_r being the cylindrical subframe of Σ^ω. The unique solution of the problem in cylindrical coordinates is isomorphic to the special Lorentz transformation L_χ, with $\beta = \nu/c$ replaced by $\beta_r = \omega r/c$. Hence the intrinsic geometry on the surface of a rotating cylinder is Euclidean. Though there exists no complete intrinsic geometry on the surface of a rotating disk, the geodesics on it are straight lines, while the circumference of a concentric circle is $K_r 2\pi r$ as predicted by Einstein. (auth)

5292 CLASSIFICATION OF STATIONARY SPACE-TIME. Perjes, Z. (Birkbech Coll., London). Int. J. Theor. Phys.; 10: No. 4, 217-227(Aug 1974).

A systematic approach to the geometric structure of stationary gravitational fields is presented. The algebraic type of the trace-free Ricci tensor together with the propagation properties of the eigenrays in the background 3-space defined by the Killing trajectories serve as a basis for classifying the solutions of the stationary field equations. The eigenrays are the integral curves belonging to the solutions ξ_A of the eigenvalue problem $G^{B\dot{C}}_{A\dot{B}} = \mu\xi_A$, G^B_A spinor representing the gravitational field in the background space. Many of the already known stationary metrics can be derived in the present scheme, but new solutions of the field equations are also obtained. The possible types of the vacuum and electrovac fields are discussed in their connection with the corresponding exact solutions. (auth)

5293 LIOUVILLE EQUATION IN GENERAL RELATIVITY. Kichenassamy, S. (Univ., Paris). Gen. Relativity Gravitation; 6: No. 1, 141-142(Feb 1975).

From 7th international conference on gravitation and relativity; Tel-Aviv, Israel (Jun 1974).

First the Γ-space of a system relative to an observer is defined and then generalizations are made along classical arguments the Liouville theorem and the Liouville equation to general relativity. (UK)

5294 DETERMINATION OF THE RATE OF CHANGE OF G. Van Flandern, T. C. (Naval Observatory, Washington, DC). Mon. Notic. Roy. Astron. Soc.; 170: No. 2, 333-342(Feb 1975)

A new analysis of lunar occultation observations from 1955 to 1974 utilizing atomic time gives a value for the empirical part of the secular acceleration of the moon's mean longitude of $(-65'' \pm 18'')/cy^2$. This differs from other determinations which utilized the ephemeris time scale, based on the apparent annual motion of the sun about the earth. These latter, which give $(-38'' \pm 4'')/cy^2$, measure only the tidal component of the moon's longitude acceleration. The remaining acceleration $(-27'' \pm 18'')/cy^2$, has as its most probable cause a decrease in the universal gravitational constant at the rate of $\dot{G}/G = (-8 \pm 5) \times 10^{-11}/yr$. There is a large body of supporting evidence for a rate of about this size, including the disappearance of the artificial "nontidal" component in the deceleration of the earth's rotation, geophysical evidence for an observed expansion of the earth's radius, and generally good agreement with recent determination of the Hubble constant, which is related to $\dot{G}/G$. The observed rate is also consistent with the Dirac (Proc. R. Soc. Lond. A; 333: 403(1973)) and the Hoyle-Narlikar (Mon. Not. R. astr. Soc.; 155: 323(1972)) cosmological theories, and to a lesser degree, with the Brans-Dicke (Phys. Rev.; 124: 925(1961)) theory. Other possible interpretations of the observed excess (negative) lunar acceleration are also discussed; but only those with cosmological significance seem at all plausible. (auth)

5295 VARIATIONAL PRINCIPLES AND GENERALIZED EQUATIONS OF INERTIAL-GRAVITATIONAL FIELD. Raigorodski, L. D. (Leningrad Shipbuilding Inst.). Acta Phys. Acad. Sci. Hung.; 37: No. 1-2, 133-139(1974).

The generalized equations of the inertial-gravitational field are derived from variational principles. It is shown that these generalized equations include the quasi-Maxwellian equations of the inertial-gravitational field. (auth)

5296 ON THE RENORMALIZATION PROBLEM OF QUANTUM GRAVITY. Kallosh, R. (P. N. Lebedev Physical Institute, Moscow, USSR). Phys. Lett., B; 55: No. 3, 321-323(17 Feb 1975).

Strong restrictions on possible counterterms are obtained using the Weyl gauge symmetrical form of the Einstein gravity. These restrictions are confirmed by the available one-loop calculations. Arguments in favor of the renormalizability of the quantum gravity are given. (auth)

5297 ON THE HIGH-ENERGY BEHAVIOUR OF BORN CROSS SECTIONS IN QUANTUM GRAVITY. Berends, F. A. (Rijksuniversiteit Leiden (Netherlands). Instituut Lorentz voor Theoretische Natuurkunde); Gastmans, R. (Louvain Univ. (Belgium). Inst. for Theoretical Physics). Nucl. Phys., B; 88: No. 1, 99-108(17 Mar 1975).

The differential cross sections for elastic graviton-scalar, graviton-photon, and graviton-graviton scattering are calculated in lowest order. It is found that they have a maximal growth with energy allowed on dimensional grounds, i.e., like E^2. It is argued that this behavior does not exclude the renormalizability of the theory. (auth)

5298 RADIATING BODIES AND NAKED SINGULARITIES. Steinmueller, B.; King, A. R.; Lasota, J. P. (Hamburg Univ. (F. R. Germany). 1. Inst. fuer Theoretische Physik). Phys. Lett., A; 51: No. 4, 191-192(10 Mar 1975).

A previously published exact solution of Einstein's equations representing a contracting radiating star is discussed and shown to provide an example of a naked singularity produced from initially regular conditions. (auth)

5299 THE CHARACTERISTIC SURFACES OF A CLASSICAL SPIN-3/2 FIELD IN AN EINSTEIN–MAXWELL BACKGROUND. Madore, J. Phys. Lett., B; 55: No. 2, 217-218(3 Feb 1975).

It is shown that the anomalous characteristic surfaces of the Rarita–Schwinger equation minimally coupled to an electromagnetic field can be eliminated by including the gravitational field provided that the charge e and mass m satisfy $m = e/\sqrt{3G}$. (auth)

5300 THE DE DONDER COORDINATE CONDITION AND MINIMAL CLASS 1 SPACE-TIME. Krause, J. (Instituto de Fisica, Universidad Catolica de Chile, Casilla 114-D, Santiago, Chile). J. Math. Phys. (N.Y.) 16: No. 5, 1090-1092 (May 1975).

By means of immersion techniques a set of "adapted coordinates" are introduced as preferred coordinates for class 1 space-time. It is proved that the necessary and sufficient condition for the adapted coordinates to be harmonic coordinates is that class 1 space-time be a minimal variety. Some interesting features of the embedding approach to curved space-time are also shown in terms of these adapted coordinates. (auth)

5301 GEODESICS AND NEWTONIAN TRAJECTORIES. Cohn, J. (Department of Physics and Astronomy, University of Oklahoma, Norman, Oklahoma 73069). J. Math. Phys. (N.Y.) 16: No. 5, 1152-1155 (May 1975).

In the framework of Riemannian geometry, the problem is considered whether there is a closest geodesic, for all possible space–time metrics, to a given Newtonian trajectory. The meaning of closeness is given precision and the question is answered—in the negative. (auth)

5302 CYLINDRICALLY SYMMETRIC STATIONARY BEAM OF ELECTROMAGNETIC RADIATION. Banerjee, A. (Department of Physics, Jadavpur University, Calcutta-32, India). J. Math. Phys. (N.Y.) 16: No. 5, 1188-1190 (May 1975).

An exact solution of Einstein–Maxwell equations corresponding to an infinite stationary beam of electromagnetic radiation with the energy flux along the axial direction of a cylindrically symmetric system is obtained. Explicit forms of the electromagnetic field tensors are given. Further, the timelike and null geodesics in the region of the beam are also discussed. (auth)

5303 QUANTITATIVE RELATIONSHIP BETWEEN CLOCK GRAVITATIONAL "RED-SHIFT" VIOLATIONS AND NONUNIVERSALITY OF FREE-FALL RATES IN NONMETRIC THEORIES OF GRAVITY. Nordtvedt, K. Jr. (Montana State University, Bozeman, Montana 59715). Phys. Rev. D 11: No. 2, 245-247 (15 Jan 1975).

When we assume conservation of energy (absence of perpetual motion of the first kind), a generally valid quantitative relationship is derived between possible violations of the clock gravitational "red-shift" effect, $\delta\nu/\nu = \delta U(1+\xi)/c^2$, $\xi \neq 0$ indicating violation, and nonuniversality of free-fall rates which can occur in nonmetric theories of gravity. (auth)

5304 ELECTROMAGNETIC RADIATION INDUCED BY A GRAVITATIONAL WAVE. Boughn, S. (Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. D 11: No. 2, 248-252 (15 Jan 1975).

The electromagnetic radiation induced by a gravitational wave incident on a point charge and a static point dipole is calculated using a multipole expansion of the fields. The calculation is easily extended to the case of a relativistic source. The presence of this radiation does not violate the principle of equivalence. Estimates are made of the electromagnetic radiation induced by a plane gravitational wave incident on a plasma. For hot plasmas the radiated power can be considerably enhanced; however, it is still rather small, and the frequency of the radiation would probably be too low for this process to be of any astrophysical significance. (auth)

5305 ON THE CURVATURE DYNAMICS FOR METRIC GRAVITATIONAL THEORIES. Camenzind, M. (Institut für Theoretische Physik, Universität Bern, Sidlerstrasse 5, 3012 Bern, Switzerland). J. Math. Phys. (N.Y.) 16: No. 5, 1023-1031 (May 1975).

Any "metric gravitation theory" (including general relativity) is shown to determine transport equations for the connection and curvature of the Lorentz frame bundle P_4 defined by the metric g. Observers are generally defined as curves in P_4 which project down to timelike trajectories in space-time. The transport of curvature along an observer trajectory is then given by a Lorentz Lie algebra-valued current composed of an internal and external part. Einstein's equations are shown to define one part of the self-dual limit of the usual Yang–Mills gauge equations, here called a particular form of curvature dynamics. As a consequence, the Yang–Mills-like energy–momentum tensor, introduced for the Lorentz connection, vanishes identically under Einstein's vacuum conditions. (auth)

REACTOR TECHNOLOGY AND REGULATION

5306 (IAEA-168) OPERATING EXPERIENCE WITH NUCLEAR POWER STATIONS IN MEMBER STATES IN 1973. (International Atomic Energy Agency, Vienna (Austria)). 1974. 266p. INIS.

The report follows the same outline as the 1972 and 1973 Agency's issues of annual reports on operating experience with nuclear power stations in Member States and consists of two parts: Part A, containing basic information on power station units which began operation in 1973 (and AKW Rheinsberg which is reported for the first time). Part B, containing operating information for the year 1973. At the end of 1973, there were 143 power reactors in operation in 17 Member States with a total capacity of 45,655 MWe. They represented an accumulated operating experience of 982 reactor years. It has not been possible to include data on all nuclear power stations in this report. The report now has data from 98 units. (INIS)

5307 SUMMARY OF OPERATING U. S. POWER REACTORS AS OF JAN. 1, 1975. Nucl. Safety; 16: No. 2, 227-232(1975).

The summary provides tabulated information about U. S. reactors (name, location, company operating reactor, reactor type, thermal and electrical design power, license number and date, two month and cumulative output and significant recent actions). (LTN)

5308 ITALIAN ENERGY SITUATION. Reports by the Ministry for State Participations, by ENEL, ENI, IRI. Com. Naz. Energ. Nucl., Not.; 21: No. 1, 75-84(Jan 1975). (In Italian).

Some documents concerning Italian energy situation are reported, with particular reference to nuclear energy. (auth)

5309 REACTOR ENGINEERING AND NUCLEAR POWER. Andrzejewski, S. (Polytechnical Inst., Warsaw). Nukleonika.; 20: No. 1, 1-13(1975). (In Russian).

A short description of the development of various types of nuclear power reactors in the world as well as difficulties which have been encountered on the way of introduction of nuclear power is given. Present status and future in this area are discussed. The development of nuclear reactor engineering at the Institute of Nuclear Research in Poland is reviewed. (auth)

5310 ELECTRICAL SUPPLY AND THE FUTURE. IV. Conclusions. Carter, J. Architects's J.; 161: No. 9, 469-472 (26 Feb 1975).

In this concluding article, the conflicts of interest between electrical supply, nuclear risks, demand and siting are presented, and changes are proposed for more accessible and socially oriented power engineering politics to deal with these. (auth)

5311 SOUTH AFRICA'S POSITION IN THE WORLD NUCLEAR ENERGY PICTURE. Roux, A. J. A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Trans. S. Afr. Inst. Electr. Eng.; 64: No. 12, 253-256(Dec 1973).

The rate of growth in the development and application of nuclear energy is described. It is expected that by the year 2000, not less than 50% of the total electricity generating capacity will be provided by nuclear energy. In order to maintain the rate of growth, certain requirements are necessary, viz., the availability of fuel and the production of enriched uranium. With regard to projected nuclear power development, the necessary fuel is for the most part based on uranium. The situation regarding this raw material in the free world and in South Africa is discussed. Mention is made of an intensification in South Africa's programme of exploration. There are two technological developments afoot which, in time, will serve to keep the increasing demand for uranium in check. These are, the recycling of plutonium and the development of fast breeder reactors. The cumulative demand for enriched uranium up to the end of 1981 is estimated at approximately 200,000 tSW/a. The world situation with regard to the enrichment of uranium is discussed. South Africa has developed a new process for uranium enrichment with a view to clearing the way to finally being able to market her huge uranium sources in the most refined forms. Work on the pilot plant is proceeding according to schedule. 90% of the pilot plant will be of South African manufacture. This has resulted in giving a new stimulus to South African industry for its transition from conventional to sophisticated manufacture. As far as the South African process for enrichment is concerned, the production cost in a plant erected in South Africa could be 20% lower than those for a gaseous diffusion plant of similar size erected in the USA. It is mentioned that the energy consumption of the South African process has over the past eight years been almost halved every two years. (auth)

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 5379, 5629, 5637, 5647, 5730, 5750, and 5757.

5312 (AECC-1) FLUID BED DRYER AND AEROPEP SOLIDIFICATION SYSTEM. Topical Report. (Aerojet Energy Conversion Co., Sacramento, Calif. (USA)). 21 Feb 1975. 152p. NRC.

The design and operation of the Aerojet Energy Conversion Company Radioactive Waste Management System are described. This system is capable of processing low-level liquid radioactive wastes that are generated during the normal course of operation of both BWR and PWR power plants. The system consists of two distinct sub-systems: the fluid bed dryer and the AEROPEP solidification system. The fluid bed dryer converts the radioactive liquid wastes to an anhydrous, free-flowing salt which is transferred to the waste container and immobilized by the AEROPEP solidification agent, creating a water-free, homogeneous, monolithic solid mass exhibiting low leachability characteristics. A detailed description of the total system, including the process description, individual component description, instrumentation and control system, and the design and operational conditions is presented. The quality assurance program in effect during design and fabrication of hardware is also described. The performance data obtained to date on the 20 gallon per hour fluid bed unit currently in operation in Sacramento, California is presented. Similar performance is projected for units capable of processing 50 gallons per hour, 75 gallons per hour, and larger input flow rates. Waste volume reduction and overall system decontamination factors for particulate matter are presented. Decontamination factor for iodine is projected. The expected annual release of radioactive material (particulate and iodine) from the fluid bed dryer due to normal operation is also projected. The properties of AEROPEP and AEROPEP monoliths are presented. The environmental impact of the waste management system on transportation of waste from the power plant to the burial site and also on burial site operations is also assessed. (auth)

5313 (AED-CONF-74-590-001, pp vp) MAINTENANCE CONDITIONS AND THEIR INFLUENCE ON THE CONSTRUCTION OF MAIN COOLANT PUMPS FOR NUCLEAR POWER PLANTS. Gaffal, K.; Klein, J. 1974. (In German).

From VGB conference on "power plant auxiliaries 1974"; Essen, F. R. Germany (4 Dec 1974).

9 figs.; 8 refs. With abstract.

In power plant auxiliaries 1974. Papers. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (F. R. Germany)).

An older and a newer variant of typical pressurized water and boiling water reactor pumps are compared to one another. The new design enabled more favourable time periods in maintenance work to be reached, whereas the radiation exposure could not be reduced in the same proportion, as is shown by the experience gained with main coolant pipes now in operation. (GE)

5314 (CONF-731218-P1, pp 95-119) MEASUREMENTS OF THE IODINE COMPOSITION IN THE PLANT ENCLOSURES OF A BWR NUCLEAR POWER PLANT. Pfeiffer, K. (Kraftwerk Union, Frankfurt am Main). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Fission-product iodine released by coolant leakage into the air in the rooms and buildings of a nuclear power station may be present as elementary iodine, gaseous inorganic or organic bound iodine, or as aerosols. The composition depends on the operating conditions at the time of release. To determine approximately the proportions of the various iodine components, experiments were carried out in a BWR nuclear power plant with various filter media, using the multi-filter method. Particulate filters, fibre filters, activated charcoal filters, KI-impregnated activated charcoal filters, and silver nitrate-impregnated catalyst carrier AC-6120 were used. The results so far obtained indicate that the component readily trapped by fiber filters (aerosol iodine) accounts for 30-40% of the total. The fraction of components readily absorbed by normal activated charcoal is 50-60%, while the fraction of components which are difficult to remove by filtration is below 10%, ranging from 3 to 6%. With simulated leakages in an experi-

mental chamber the proportion of aerosol iodine was sometimes as high as 80%. (auth)

5315 (CONF-731218-P1, pp 315-327) METHODS USED AT KEMA FOR MEASURING IODINE ADSORPTION ON CHARCOAL AND EXPERIENCES WITH CHARCOAL FILTERS INSTALLED AT A NUCLEAR POWER PLANT. van der Lught, G.; Scholten, L. C. (KEMA, Arnhem, Netherlands). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The KEMA reactor laboratory includes an installation for the measurement of the adsorption of iodine by small beds of charcoal. The temperature, humidity, and dimensions of the bed and the flow velocity of the air in the bed are variable. A description of the apparatus is given, especially the differences exhibited with respect to other similar installations. Methods for in-place testing of charcoal filters are briefly described. Experiences with iodine filters installed since 1968 at the Dodewaard nuclear power plant are given. Samples of charcoal used in these filters were measured periodically at the laboratory. (auth)

5316 (CONF-731218-P1, pp 547-563) BACKGROUND INFORMATION FOR USAEC REGULATORY GUIDE 1.52. Zavadoski, R. (Atomic Energy Commission, Washington, DC). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The Regulatory Guide 1.52 is the first standardization guide issued by the USAEC. It is the first guide dealing with engineered safety feature filtration systems. The bases for many of the positions in the guide are derived from its dual role of standardization and filtration systems guidance. An exposition of the background bases for the positions taken in the guide in terms of its dual role is presented together with a copy of the guide itself. (auth)

5317 (ERDA-25) LWR SPENT FUEL DISPOSITION CAPABILITIES, 1975-1984. (Energy Research and Development Administration, Aiken, S.C. (USA). Savannah River Operations Office). Mar 1975. 26p. Dep. NTIS $4.00.

The disposition of spent fuel by storage or reprocessing is a critical part of the light water nuclear fuel cycle. Since fuel discharged from light water reactors (LWR's) contains significant quantities of fissile material (equivalent to about 50 percent of the original amount), chemical reprocessing has been assumed an integral part of the fuel cycle for LWR's. Generally, storage within the system for spent LWR fuel incorporates operating flexibility at the reactors and batching considerations at reprocessing sites. Projected discharges of light water reactor fuel are compared with storage and reprocessing capabilities for disposition of these fuels. The data indicate that reprocessing capacity keeping pace with nuclear power development is the key to avoid reactor shutdowns resulting from filled basins. Utilities, however, are generally aware of this situation and are currently studying plans to expand basin capacity at reactor sites as an interim measure to alleviate this situation. ERDA will continue to evaluate and coordinate spent fuel disposition capabilities and requirements with the utility and fuel reprocessing industries. (auth)

5318 (EUR-5228d) GUNDREMMINGEN (KRB) NUCLEAR POWER PLANT. Annual Report, 1973. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen/Guenzburg (F. R. Germany)). 1974. 93p. (In German). Dep. NTIS (US Sales Only) $7.75. EUR FB 125,-.

Plant reliability and availability during 1973 was very good despite an unscheduled shutdown in October. A temporal availability of 79.42% and an operating availability of 79.07% yielded a usable current production of 1,634,000,000,000 kWh. In May, during the five-week inspection and refuelling period, several machines and items of equipment were overhauled in addition to the major generator strip-down, and checks were also carried out on the safety and protection systems throughout the plant. Particular attention was paid to the fire-protection system so that, for example, a fire-protection valve was installed in the turbine oil circuit. The heating system was made independent of oil supplies and considerable economies were achieved by converting it from oil-firing to secondary steam operation. During October copper deposits from a feedwater pre-heater were discovered in the reactor core. The plant had to be shut down for five weeks in order to clean the reactor out with various items of cleaning equipment. After the plant had been started up again, it proved necessary to take the pre-heater releasing copper out of service. This was possible without any noteworthy loss of power. For further operation, it will be necessary to fit the pre-heater with high-grade steel tubes. Throughout the remainder of the year, the power plant operated under full load without any particular malfunction occurring. At the beginning of the year increasing amount of activity in the reactor water pointed to fuel element damage. It was possible to operate the plant at a constant, low level of water activity during the second half of the year after refuelling and the removal of the faulty elements. Faultless plant operation can likewise be expected for 1974. Owing to the officially required pressure test on the reactor pressure vessel, the inspection time will probably extend over six weeks. It is expected that plant availability during 1974 will exceed the 1973 figure. (auth)

5319 (EUR-5257e) EURCYL: A PROGRAM TO GENERATE FINITE ELEMENT MESHES FOR PRESSURE VESSEL NOZZLES. De Windt, P.; Reynen, J. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 40p. Dep. NTIS (US Sales Only) $5.00. EUR B. Fr. 120,-.

5320 (NEDO-20853) MARK III CONFIRMATORY TEST PROGRAM. Eighth Quarterly Progress Report. Bilanin, W. J. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Apr 1975. 23p. General Electric Co., San Jose, CA 95125.

The NRC and ACRS have recently identified certain concerns regarding the Mark III Confirmatory Testing and Model Verification Program. The more important of these concerns are the pressure oscillations observed during PSTF testing and the need for additional vent flow model/PSTF data comparisons; these two concerns are discussed. General Electric has responded to these concerns by first, demonstrating that the various oscillatory phenomena are understood, and then by describing how the oscillations have been considered in the Mark III design; second, by performing additional vent flow model/PSTF data comparisons. At this time it is concluded that, based on available test data the pressure oscillations observed during PSTF testing do not present a design concern for the Mark III system. For the comparisons performed, the vent flow model run in the Mark III mode accurately predicts PSTF measured vent flow. Vent flow comparison information presented within represents the progress made during the first stage of an ongoing model verification effort. (auth)

5321 (RT/ING-74-19) EXPERIMENTAL INVESTIGATION OF MASS VELOCITY DISTRIBUTION AND VELOCITY PROFILES IN an LWR ROD BUNDLE. Marinelli, V.; Pastori, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1974. 19p. INIS.

From European two-phase flow group meeting; Rome, Italy (8 Jun 1972).

Experimental data of mass velocity distribution among the subchannels of a square geometry 4×4 rods test section under single-phase flow conditions are presented. Such data are compared with the calculation results obtained by means of the LEUCIPPO computer code and also by means of Ibragimov theory. (INIS)

5322 RESEARCH WORK AND DEVELOPMENT OF PCPV FOR A LIGHT WATER REACTOR. Bremer, F. (Krupp (Friedr.) GmbH, Essen, Ger.). J. Brit. Nucl. Energy Soc.; 14: No. 1, 49-55(Jan 1975).

Current safety problems posed by pressure vessels for light water reactors are considered. German technology in developing a prestressed concrete pressure vessel for LWRs is described, particular attention being paid to the method of insulation. Special material was developed for the insulation which is sealed on the reactor side by a hot liner. The extensive investigations made into the resistance of the liner to strains occurring in the reactor and also the testing of the welded connection are described. The design principle of the top closure arrangement, the cold liner and the penetrations through the vessel are explained. Reference is also made to instrumentation and leakage control. (UK)

5323 DEVELOPMENT OF A PRESTRESSED CONCRETE VESSEL WITH HOT LINER. Grumm, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna); Zemann, H.; Nemet, J. J. Brit. Nucl. Energy Soc.; 14: No. 1, 57-62(Jan 1975).

A survey of the development of a prestressed concrete reactor vessel with hot liner is given. A large-scale model based on this concept is under construction in the Austrian Research Center at Seibersdorf. One of the purposes is to study the feasibility of the hot liner concept, which would enable inspection and repair of the liner during the vessel lifetime. By-products of this investigation are in the fields of welding technology, prestressing cable, isolation technology, behavior of concrete and instrumentation at high temperatures. It is intended to examine the applicability of this vessel both for gas cooled high temperature reactors and for light water reactors. First pressure tests are planned for mid 1975. (auth)

5324 PCRVs FOR BWRs. A New Dimension in LWR Exploitation. Margen, P. H.; Menon, S. (Aktiebolaget Alomenergi,

Studsvik, Sweden). J. Brit. Nucl. Energy Soc.; 14: No. 1, 35-48(Jan 1975).

Work has been in progress in the Scandinavian countries for the adaption of prestressed concrete reactor vessels to light water reactors, particularly to the BWR. A summary is given of the basic BWR concept, the prestressed concrete reactor vessel, and the station design. A detailed account is given of the PCRV design philosopy, verification work already performed, and that to be completed under the current program. Reference is made also to construction schedules and costs. A supplementary article describes the development of a liner venting system. (UK)

5325 FRENCH PROGRAMMES IN THE AREA OF REACTORS AND ENRICHMENT OF URANIUM. Pecqueur, M. J. Brit. Nucl. Energy Soc.; 14: No. 1, 11-16(Jan 1975).

Past energy demand in France and forecasts for the future are briefly considered. The program for the implementation of nuclear power plant is then discussed. The main features are the comprehensive LWR program, the program for advanced reactor development, especially for fast breeder reactors, various applications of nuclear energy, and the industrial development of various stages of the fuel cycle. (UK)

5326 JAPAN'S ENERGY PLAN UP TO 1981. Com. Naz. Energ. Nucl., Not.; 21: No. 1, 68-69(Jan 1975). (In Italian).

A discussion of Japan's energy plan up to 1981, including a tabulation of the nuclear plants in operation, under construction or planned in that country is presented. (auth)

5327 SWEDEN'S BIGGER AND BETTER BWR. Smith, D. Nucl. Eng. Int.; 20: No. 224, 43-47(Jan 1975).

The principal characteristics of Sweden's new BWR 75 design, which has unit output of either 1000 or 1300 MW(e), are described, and comparisons are made with earlier ASEA-Atom BWR's. The major innovations are concerned with changes in the layout and housing of vital systems which result in improvements in safety, easier access and maintenance, and higher availability. Details are given of the core design, emergency cooling, separation of redundant safety systems, and of the containment and buildings. (UK).

5328 NUCLEAR VESSELS ARE SAFE. Cooper, W. E. (Teledyne Materials Research, Waltham, MA); Langer, B. F. Mech. Eng.; 97: No. 4, 18-23(Apr 1975).

Arguments are presented that nuclear vessels are safe because of developments in the technology, regulations which assure that the newest proven technologies are used, and the service records of vessels in both nuclear and nonnuclear applications. (auth)

5329 EXPERIMENTAL DATA ON BURN-OUT IN A SIMULATED BWR FUEL BUNDLE. Lucchini, F. (Centro Informazioni Studi Esperienze, Milan (Italy)); Marinelli, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Nucl. Eng. Des.; 31: No. 3, 371-378(1974).

Critical heat flux (CHF) experiments have been carried out on a 16-rod test section having the typical geometry of boiling water reactor (BWR) fuel elements and in particular a 366 cm length. Heat fluxes were uniform, both axially and radially. The tests were carried out for the CNEN Plutonium Program on CISE's 8 MW IETI-3 facility, at 71 kg/cm^2 abs, mass velocities of 12-200 g/cm^{2}s and inlet sub-cooling of 15-180°C. Each corner rod was instrumented with four separate thermocouples to detect and locate the initiation of CHF, while the other rods were instrumented with four-junction thermopiles. (auth)

5330 A NEW CALCULATION METHOD FOR THE DETERMINATION OF THE NON-STATIONARY THREE-DIMENSIONAL POWER DISTRIBUTION IN LARGE LIGHT-WATER REACTOR CORES. Extract. Schmidt, A. Munich; Technische Univ. (1974). 21p. (In German). INIS.

Thesis.

Perturbations in small reactor cores in most cases lead to global effects, therefore simple point kinetic models are sufficient for their simulation. In large cores, the study of local effects is much more important because of the existing spatial decoupling. Such perturbations cannot be measured in general by the in-core instrumentation during reactor operation. A three-dimensional calculation model is presented allowing the simulation of the behavior of large light-water reactors under transient conditions within the range of seconds. (GE)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 5312, 5313, 5316, 5317, 5319, 5321–5323, 5325, 5326, 5328, 5330, 5379, 5599, 5600, 5604, 5609, 5622, 5623, 5625–5629, 5637, 5647, 5716, 5730, 5750, and 5753–5756.

5331 (AED-CONF-74-590-003, pp vp) ARRANGEMENT OF THE ND-FEED HEATER IN THE TURBINE EXHAUST STEAM NOZZLE, CIRCUITS, TYPES OF CONSTRUCTION AND ASSEMBLY POSSIBILITIES. Welch, R. 1974. (In German).

From VGB conference on "power plant auxiliaries 1974"; Essen, F. R. Germany (4 Dec 1974).

In power plant auxiliaries 1974. Papers. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (F. R. Germany)).

A brief survey is given of the development and installation of both lower ND-feed heater stages (duplex immersion type heaters) such as are installed in Biblis-A. (GE)

5332 (GKSS-74/E/42) HEAT TRANSFER PROPERTIES OF FUEL PINS DETERMINED BY NOISE ANALYSIS. Robinson, E. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (F. R. Germany)). 21 Oct 1974. 14p. (CONF-741030-8; SM-190/11). Dep. NTIS (US Sales Only) $4.00.

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

A measuring method is presented, by which the heat transfer constants of fuel pins, inserted in a nuclear light water reactor, are determined by cross-power spectral density measurements, utilizing power reactor noise. The phase of a measured transfer function between reactor power fluctuations and the signal of a high temperature thermocouple in a fuel pin is interpreted by a point model of the temperature dynamics of the fuel rod. The effect of the thermocouple time constant is also considered. The model is shown to be adequate in the analyzed frequency region. (10 references) (auth)

5333 (KFK-2050, pp 169-172) EXPERIMENTAL STUDIES ON CHEMICAL INTERACTIONS OF FUEL/ZIRCALOY CLADDING. Hofmann, P.; Goetzmann, O. Aug 1974. (In German).

In 1st semi-annual report 1974.

The reaction behavior of Zircaloy-4 Zry-4 cladding material as compared with oxide fuel and fission products was out-of-pile examined at very high temperatures (up to 1,300°C) that could arise in the case of a loss-of-coolant accident. The simulated burn-up was 10 at.%, the O/U ratio of UO_2 about 2.08. The fission products cesium, iodine, and tellurium were simulated which proved to be reactive to Zry-4 due to thermodynamic estimations. The cladding tube burst between 850 and 900°C as a result of the inner pressure (pressure build-up by the filling gas and the volatile fission products). One can observe a structural change of the Zry on the inner surface of the cladding tube due to the uptake of oxygen. Microhardness tests showed that this phase is about twice as hard as the rest of the cladding material. (GE)

5334 (RISO-318) DESCRIPTION OF THE REAL TIME PWR POWER PLANT MODEL PWR-PLASIM. la Cour Christensen, P. (Danish Atomic Energy Commission, Risoe, Research Establishment). Nov 1974. 73p. Dep. NTIS (US Sales Only) $7.00.

A description is given of a PWR power plant model working in real time on a hybrid computer. The basic equations are derived and simplifications discussed. Independent, detailed models were prepared for the steam generator, the pressurizer and the reactor fuel and used in the development of simpler models. The independent, detailed models are included in the presentation. (auth)

5335 (RISO-M-1778) USE OF THORIUM IN A PWR. Hoejerup, C. F. (Danish Atomic Energy Commission, Risoe, Research Establishment). 6 Mar 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

Burnup calculations have been made for PWR-type lattices containing $^{233}UO_2$, ThO_2 and various kinds of booster material (PuO_2 recovered from normal PWR operation, low enriched UO_2 and high enriched UO_2). The results show that breeding is practically impossible, but an improved conversion ratio (compared with the normal U–Pu operation) can be obtained, with increased energy production per unit of natural uranium consumed as a consequence. (auth)

5336 (WCAP-8370(Rev.7-A)) QUALITY ASSURANCE PLAN, WESTINGHOUSE NUCLEAR ENERGY SYSTEMS DIVISIONS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Nuclear Energy Systems Div.). Feb 1975. vp. Westinghouse Electric Corp., Pittsburgh, PA.

The Quality Assurance Program used by Westinghouse Nuclear Energy Systems (NES) Divisions is described. The purpose of the program is to assure that the design, materials, and workmanship on Nuclear Steam Supply System (NSSS) equipment meet applicable safety requirements, fulfill the requirements of the contracts with the applicants, and satisfy the applicable codes,

standards, and regulatory requirements. This plan satisfies the AEC Quality Assurance Criteria, 10CFR50 Appendix B, to the extent that these criteria apply to safety related NSSS equipment. Also, it follows the guidance of the standards and regulatory guides contained within the AEC's "Gray" book, WASH 1283, Rev. 1, May 24, 1974, and the "Green" book, WASH 1309, May 10, 1974, and the "Orange" Book, WASH-1284, October 26, 1973. (auth)

5337 TNE YEARS OF EXPERIENCE IN OPERATING THE NOVO-VORONEZH ATOMIC POWER STATION. Grigor'yants, A. N.; Ovchinnikov, F. Ya.; Sedov, V. K.; Golubev, L. I.; Akkuratnov, Yu. A.; Prokopenko, I. V.; Kustov, I. I.; Isakov, N. A.; Dobrynin, V. L.; Tsybul'nik, A. V.; Skrypnikov, T. I. At. Energ. (USSR); 38: No. 1, 3-10(Jan 1975). (In Russian).

Experience gained in operating the Novo-Voronezh Atomic Power Station, the first section of which went into operation on September 30, 1964, is described. After initiation of the second (1969), third (1971) and fourth (1972) sections, the power of the Novo-Voronezh station now amounts to 1455 MW (elec.). There is presented a vast amount of data providing engineering and economic indicators on the operation of the station, its flexibility and stability, information on the operation of the basic equipment, experience gained in repairs and fuel re-charging. The basic results of research performed by station personnel are summarized. (auth)

5338 INTEGRATED PWR FOR SMALL AND MEDIUM SIZED NUCLEAR POWER PLANTS. Harde, R.; Breyer, W.; Holling, E. (International Atomreaktorbau GmbH (INTERATOM), Bensberg, Ger.). Nucl. Eng. Int.; 20: No.224, 48-50(Jan 1975).

The integrated pressurized water reactor developed by Interatom for use in land-based power plants of small and medium capacity is discussed. In order to achieve low investment cost and maximum reliability, components which had been proven in the Otto Hahn reactor and in the standard light water reactors of Kraftwerke Union are incorporated into the design where possible. The main features are summarized, and the nuclear steam supply system is described. Overall data for a range of standard sizes from 120 to 1000 MW(t) are given. The system is licensable under the present safety design criteria and is economically superior to oil fired plants of 100 MW(e) and above. (UK)

5339 TWO DESIGNS FOR SMALL AND MEDIUM CAPACITY LWR POWER GENERATORS. Nucl. Eng. Int.; 20: No. 224, 51-55(Jan 1975).

Two nuclear power systems designed for small power and specialized services are offered by the joint CEA and EdF company, Technicatome. One is based on an integrated pressurized water reactor and the other a looped PWR. The systems are designed to produce saturated or slightly superheated steam which may be used to drive a turbo generator or used directly in chemical processing, desalination, on-board marine propulsion, and other industrial processing applications. Brief descriptions and general specifications are given. (UK)

5340 DEVELOPMENT OF NUCLEAR POWER IN THE PEOPLE'S REPUBLIC OF BULGARIA. Int. At. Energy Agency Bull.; 16: No. 6, 19-23(Dec 1974).

A report is presented on the construction and commissioning of the Kozloduy-1 reactor. (DG)

5341 RAPID REFUELING SYSTEM FOR NUCLEAR POWER PLANTS. Andrews, H. N.; Deroy, G. L.; Olmstead, C. A. (Westinghouse Electric Corp., Monroeville, PA). Westinghouse Eng.; 34: No. 2, 53-59.

As the number and size of nuclear power plants increase, the search for ways to optimize their operation becomes increasingly important. The refueling process presently offers the greatest potential for operational and economic improvements. The Westinghouse Rapid Refueling System is an integrated package of equipment designs that can reduce the refueling time to less than seven days and thereby permit improvements in plant operating flexibility and nuclear fuel economics, and a reduction in manpower requirements. A planned plant maintenance program has been prepared to assure that the necessary maintenance procedures can be completed in the shorter time period required to take full advantage of the Rapid Refueling System. (auth)

5342 DIRECTIONS OF STEAM-GENERATOR PROGRESS FOR PRESSURE WATER REACTORS. Krizek, V. (Research Inst. of Nuclear Tech., Brno). Jad. Energ.; 21: No. 2, 44-51 (Feb 1975). (In Czech).

There are given the main directions of the steam-generator solution conception progress of the pressure water reactors. The individual types, corpus horizontal and vertical steam-generators for the saturated vapor production, are compared. The through-flow corpus steam-generator progress and the application possibilities of the module steam-generator conception are outlined. Beside the projection solution, the technology, transport, assembly and exploitation problems of the individual types of the steam-generators are mentioned, especially from the point of view of the nearest perspective needs in the Czechoslovak Socialist Republic. (21 references) (auth)

5343 OCONEE 1 COMPLETES FIRST CORE CYCLE. Mayer, J. T.; Hladek, K. L. (Babcock and Wilcox Co., Lynchburg, VA). Elec. World; 183: No. 7, 33-36(1 Apr 1975).

The performance of the first cycle fuel elements for Oconee-1 Reactor is analyzed. Operating data and post-irradiation examination results are presented. Refueling procedures and health physics aspects are described. (DCC)

5344 DOEL NUCLEAR POWER STATION. Potemans, M. Atoomenergie Haar Toepass.; 17: No. 3, 68-73(Mar 1975). (In Dutch).

A general description is presented of the Doel nuclear power station, located on the Dutch-Belgian border some 15 km NW of Antwerp. The principle nuclear features are: two PWR reactors, each designed for ~390 MWe output; each reactor core contains 179 multi-pin fuel elements whose fissile content is ^{235}U, at a mean enrichment of 2.75%; planned fuel burn-up ~33,000 MW d/t; saturated steam outlet temperature and pressure, 275°C and 60 kg/cm^2 respectively. Reactor I was commissioned in February 1975, and commissioning of Reactor II is expected to follow in July or August 1975. Brief accounts are also included of the station's electrical, mechanical, and civil engineering aspects. (NL)

5345 MATERIAL SELECTION AND OPERATIONAL EXPERIENCE WITH CLADDINGS OF PWR-COMPONENTS. Moeller, W. Z. Werkstofftech.; 6: No. 1, 6-10(Jan 1975). (In German).

From reactor meeting; Berlin, F. R. Germany (2 Apr 1974).

Considering the choice between nonstabilized and stabilized stainless CrNi-steels for nuclear primary systems we find deviating views among the experts in the world. Outside Germany exclusively nonstabilized 18-8 CrNi-steel is in use, while in Germany stabilization is indispensible to meet the requirement for resistance to intergranular corrosion. This requirement is the consequence of failures in nuclear power plants caused by stress corrosion. Therefore, the fundamental aspects of the susceptibility to intergranular corrosion, tests and stress-induced intergranular corrosion are described. These relationships, assessment of advantages and disadvantages of both types of steel and an evaluation of an extensive list of plant failures up to mid 1973 have led to the conclusion that the use of nonstabilized 18-8 CrNi-steel for claddings of PWR-components is to be preferred. An intergranular corrosion test seems to be doubtful to prove the resistance to stress corrosion. (auth)

Power Reactors, Non-Breeding, Graphite Moderated

Refer also to abstracts 3940, 5011, 5323, 5379, 5605, 5610, 5645, and 5729.

5346 (AED-CONF-74-497-001) USE OF DISODIUM HYDROGEN PHOSPHATE IN THE ONCE-THROUGH STEAM GENERATOR OF AN ENGLISH NUCLEAR POWER PLANT. Parry, D. J.; Tasker, P. W.; Tyldesley, J. D. (Central Electricity Generating Board, London (UK)). 1974. 12p. (In German). INIS.

From VGB conference on chemistry in the power plant 1974, VGB feed water conference 1974; Essen, F. R. Germany (29 Oct 1974).

The paper deals with ionizing impurities in the water-steam circuit of a nuclear once-through boiler and with experiments using a partial model of a low-pressure once-through boiler. (GE)

5347 (CEA-CONF-2845) FISSION PRODUCTS PROBLEMS IN A HEAT PROCESS PLANT. Brisbois, J.; L'Homme, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). 1974. 10p. (CONF-741144-2). Dep. NTIS (US Sales Only) $4.00.

From BNES international conference on the HTR process application; London, UK (26 Nov 1974).

The use of a nuclear reactor with a chemical factory, using reactor heat to produce hydrogen poses a major problem: the radionuclide release of the plant to the atmosphere either directly

to the environment or indirectly and by subsequent utilization of contaminated hydrogen in home or industrial applications. The levels to which this release must be limited are described. The radionuclide release from a heat process plant is compared to the release with that from an electro nuclear reactor of same power and type (high temperature reactor). Improvements which can be made on the system and their efficiency are discussed. (auth)

5348 (CEA-CONF-2846) SOME CEA STUDIES ON METAL BEHAVIOR IN HTR. Dixmier, J.; Willermoz, H.; Roche, R. (CEA, 75 - Paris (France)). 1974. 14p. (CONF-741144-4). Dep. NTIS (US Sales Only) $4.00.

From BNES international conference on the HTR process application; London, UK (26 Nov 1974).

Behavior of defractory metals in HTR type helium has been examined at high temperature. Alloys hardened by titanium and aluminum additions show severe intergranular attack at 800°C. At higher temperatures (900°C range) this phenomena is very reduced. Other refractory alloys like Inconel 600, Hastelloy X and Molybdenum alloys are not affected by the temperature increase from 800°C to 900°C. Niobium alloys are strongly hardened in this temperature range. Friction and wear tests are in progress for temperatures between 500 and 1000°C. Descriptions of test apparatus and procedures are given. (auth)

5349 (CONF-731218-P1, pp 25-36) BEHAVIOR OF IODINE SPECIES IN THE WINDSCALE AGR. Hillary, J. J. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Iodine-131 has been released into the coolant of WAGR from a number of deliberately or operationally defected fuel pins. This iodine has been found principally in the form of methyl iodide and, based on the majority of the results, has a chemical decomposition half-life, due to plate-out during passage through the gas circuit, of about 2½ min. Methyl iodide which was injected separately into the circulating coolant was found to have a similar half-life. The ratio of the steady state Iodine-131 release from the fuel to that remaining gasborne was found to be 4,500. The deposition of iodine has been observed on the cooler surfaces of the heat exchangers. The deposition velocity, corresponding to a 2½ min half-life, for these heat exchanger surfaces was 0.02 cm/sec. (auth)

5350 (CONF-731218-P1, pp 53-69) TRAPPING AND DESORPTION OF IODINE IN GRAPHITE-GAS REACTORS. Sigli, P. (CEA, Fontenay-aux-Roses, France); Benezech, G.; Miribel, J.; Barbier, J.; Cadet, B. Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Operational monitoring in the six gas-cooled graphite-moderated reactors used by Electricité de France has suggested that iodine trapping might be occurring in internal structures. To confirm this theory, an experiment was carried out on the CHINON-1 reactor. It entailed injecting radioactive iodine into the primary circuit and studying the changes in its concentration and physical and chemical nature. The results showed that transformation of molecular iodine into a penetrating form was very rapid. High rates of trapping by internal structures were observed. The desorption phenomenon was slow. (auth)

5351 (CONF-731218-P1, pp 71-93) IODINE PARTITION BETWEEN THE DIFFERENT MEDIA OF A GRAPHITE-GAS REACTOR AND ITS ENVIRONMENT. Barbier, J. (Electricite de France, Paris). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

As a fission product, iodine 131 forms part of a chain linking tin, antimony, and tellurium 131 and 131m. The partition of iodine among the various media of the plant, namely fuel, carbon dioxide, walls, and environment, depends largely on the behavior of tellurium 131 and tellurium 131m. Two experiments prove that almost all the iodine found in the environment comes from tellurium. To demonstrate this theory conclusively it would be necessary to show that tellurium exists in a still more penetrating form than that observed for iodine. If this is so, environmental protection against iodine contamination using special iodine trapping techniques is inadequate; one should think of using trapping techniques to remove tellurium as well as iodine. (auth)

5352 (CONF-731218-P1, pp 149-162) DESIGN OF IODINE TRAPPING PLANTS IN THE UK FOR CEGB GAS-COOLED REACTOR USE. Passant, F. H. (Central Electricity Generating Board, Cheltenham, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The design principles and practice for iodine adsorption plants used at the Central Electricity Generating Board's CO_2 cooled reactors are described. In general, a single adsorption bed has been provided on magnox reactor stations through which the reactor coolant can be discharged to atmosphere following the unlikely event of a major release of fission products into the reactor circuit. The Advanced Gas-Cooled Reactor stations under construction employ several adsorption beds for routine discharge of reactor coolant, charge/discharge machine coolant and fuel handling cells coolant in addition to an emergency use adsorption bed. The adsorption beds, all utilizing impregnated activated charcoal, have been improved in design over the years to accommodate more stringent requirements for performance, reliability and ease of maintenance. Descriptions are given of current designs including provisions for testing and servicing and the provision of pre- and post-filtration in conjunction with the adsorption beds. Incorporation of iodine adsorption beds into ventilation systems associated with CEGB nuclear power stations has not been necessary, but the design of such beds is under consideration for possible future use on AGRs. A brief description of the type of bed likely to be employed is given. (auth)

5353 (CONF-731218-P1, pp 199-210) UTILIZATION OF SILVERED ZEOLITES FOR IODINE TRAPPING AT HIGH TEMPERATURE. Belval, M.; Miribel, J. (CEN, Cadarache, France). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The problem of trapping iodine in loops at high temperatures, as it bears on studies of safety problems, has been solved by the use of 13X silver-coated molecular sieves. Tests which have been carried out on various materials are described. An economical method of trapping is the use of a 260 g/l silver-coated 13X sieve. Its efficiency at 400°C and a flow rate of 70 cm/s is in the region of 10^4. The method of manufacturing the sieves and the various tests conducted in order to determine manufacturing standards are described. (auth)

5354 (CONF-731218-P1, pp 391-404) EXPERIENCE IN TESTING IODINE SORPTION PLANTS ASSOCIATED WITH CEGB GAS-COOLED REACTORS. Stead, M. (Central Electricity Generating Board, London). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Each of the C.E.G.B.'s eight nuclear power stations currently operating in the U.K. has an adsorption plant through which the reactor coolant can be discharged in the unlikely event of a major release of fission products into the reactor circuit. The adsorption plant consists of a bed of impregnated activated charcoal together with pre- and post-filters and is designed to remove particulate fission products and all forms of iodine with good efficiency. In-situ tests of the plants revealed weaknesses in design of the charcoal beds which resulted in low efficiency for iodine removal. Remedial work has been carried out and the efficiencies much improved. The remedial work is described. A program of periodic testing and refurbishing of the Board's plants is being established and is discussed. (auth)

5355 (GA-A-12808) LARGE HTGR STEAM GENERATOR DESIGN VERIFICATION AND SUPPORT PROGRAMS. Duncan, D. S. (General Atomic Co., San Diego, Calif. (USA)). 10 Mar 1975. 44p. (GA-LTR-5). General Electric, San Diego, CA.

Additional information on heat transfer, fluid flow, and stability studies concerning steam generators for HTGR's is presented. (JWR)

5356 (GERHTR-120) DRAGON-KFA COLLABORATION FOR THE SUPPLY OF HTR-GRAPHITE. Leushacke, D. F. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). 17 Apr 1974. 7p. Dep. NTIS (US Sales Only) $4.00.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

The role of the joint DRAGON-KFA activities in graphite development for high-temperature reactors is reviewed. (JWR)

5357 (GERHTR-123) CHEMICAL BEHAVIOR AND IMPROVED RETENTION OF FISSION PRODUCTS IN IRRADIATED HTGR FUELS. Foerthmann, R.; Gruebmeier, H.; Kleykamp, H.; Naoumidis, A. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). 1974. 18p. (CONF-741030-12; SM-190/35). Dep. NTIS (US Sales Only) $4.00.

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

Work performed under United States-German High Temperature Reactor Research Exchange Program.

Electron microprobe analysis on irradiated coated particles with high burnups (50% FIMA) gives detailed information on the chemical state and the transport behavior of solid fission products. Metallic fission products form different types of Mo–Tc–Ru–Rh and Pd–Te inclusions, oxide forming fission products are precipitated as compounds e.g., (Sr, Ba)ZrO_3 or form solid solutions with the oxide kernel matrix (rare earths, Sr, Zr). Cs is preferentially deposited in fission gas pores. In carbide fuel kernels fission product inclusions could not be detected. Corresponding to the chemical state in the kernel the following fission products are released easily from the kernel and diffuse through the entire pyrocarbon coating: Cs, Sr, Ba, Pd and from carbide kernels additionally the rare earths. These fission products can be retained by a silicon carbide layer. A first irradiation experiment demonstrates the possibility of increasing the kernel retention by changing the chemical state of solid fission products. By electron microprobe analysis a strong chemical reaction between additional oxide inclusions consisting of alumina-silica mixture and the fission products Cs, Sr, Ba in the kernel is proved. The best gettering effect is observed at $1 < Si/Al < 3$ probably corresponding to the formation of the compounds $CsAlSi_2O_6$ and (Sr,Ba)$Al_2Si_2O_8$ in the inclusions. Consequently, postirradiation annealing experiments result in a considerable reduction of the Cs release from pyrocarbon coated fuel particles by more than two orders of magnitude, if the kernel contains alumina-silica additives. (auth)

5358 (JAERI-M-5661) DELIGHT-2: THE POINT REACTIVITY BURNUP CODE FOR HIGH-TEMPERATURE GAS-COOLED REACTOR CELLS. Shindo, R.; Hirano, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Apr 1974. 53p. (In Japanese). INIS.

The DELIGHT code, developed to analyze the burnup characteristics for cells of graphite moderated reactors with fuel elements composed of coated fuel particles, has been revised to increase the accuracy of calculations. Improvements in the DELIGHT-2 are as follows: (1) The doubly space-heterogeneous effect of fuel (dispersion of coated fuel particles in the graphite matrix and regular array of fuel rods in the graphite block) is considered for calculation of the resonance absorption. (2) The chemical binding effect of graphite is taken in the scattering of thermal neutrons. (3) The fine distribution of flux in the unit cell can be calculated. (4) The depletion of boron (^{10}B) with burnup is treated in reactivity calculations. The DELIGHT-2 code will thus be sufficient as a calculational model for the nuclear design of high-temperature gas-cooled reactor cores. (auth)

5359 (JAERI-M-5690) COMPUTER CODE FOR THE ANALYSIS OF GRAPHITE CORROSION IN HTGR: "PEGASUS." Suzuki, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). May 1974. 44p. INIS.

The steam-graphite reaction ($H_2O + C \rightarrow CO + H_2$) is of interest for gas-cooled reactors because of the use of graphite core structural material in the High Temperature Gas-Cooled Reactors and the possible presence of water vapor in the coolant either as an impurity or through inleakage from the secondary loops, especially from the steam generator. In order to analyze the effects of that reaction in the reactor core, the computer code "PEGASUS" has been developed in which the problems are formulated mathematically as the unsteady diffusion problem with the first order chemical reaction and solved numerically under the third kind of boundary conditions. Some of the assumptions in the code are as follows: (1) the graphite is cylindrically symmetric, (2) the steam-graphite reaction in the core is of the first order, and (3) the transport of reactants into the graphite is governed by their diffusion. This computer code can be used for the calculation of water vapor concentration as a function of time and position in the graphite cylinder, corrosion rates and corrosion losses of graphite cylinder, linear corrosions of the outermost P_yC-layer of coated particle fuel, and depth of the permeation of water vapor into graphite cylinder. (auth)

5360 (JUL-1159) STATUS AND ASPECTS OF FUEL ELEMENT DEVELOPMENT FOR ADVANCED HIGH TEMPERATURE REACTORS IN THE FRG. Nickel, H.; Balthesen, E. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jan 1975. 43p. (In German). Dep. NTIS (US Sales Only) $5.25.

In the FRG three basic fuel element designs for application in high temperature gas cooled reactors are being pursued: the spherical element, the graphite block element, and the moulded block element (monolith). This report gives the state of development reached with the three types of elements but also views their specific merits and performance margin and presents aspects of their future development potential for operation in advanced HTGR plants. The development of coated feed and breed particles for application in all HTGR fuel elements is treated in more detail. Summarizing it can be said that all the fuel elements as well as their components have proved their aptitude for the dual cycle systems in numerous fuel element and particle performance tests. To adapt these fuel elements and coated particles for advanced reactor concepts and to develop them up to full technical maturity further testing is still necessary, however. Ways of overcoming problems arising from the more stringent requirements are shown. (auth)

5361 (TRG-Report-2287(S/X)) INFLUENCE OF CRACKS IN NUCLEAR FUEL UPON THE ELASTIC THERMAL BOWING OF SOME SGHWR AND AGR FUEL ELEMENTS AT STEADY POWER. Gardner, L. R. T. (UKAEA Reactor Group, Risley). Feb 1975. 30p. Dep. NTIS (US Sales Only) $4.50. HMSO £1.00.

A model is described which reproduces many of the bending characteristics of a cracked fuel in intimate contact with its cladding. The model extends earlier work in allowing different diametral temperature gradients across the fuel and the can to be analyzed. Application to SGHWR and AGR pins is made. It is concluded that fuel, even though cracked, can produce a significant effect on bowing and on grid loads. (auth)

5362 HYDROGEN PRODUCTION AND HIGH TEMPERATURE REACTORS. Beghi, G. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 22: No. 2, 69-77(Feb 1975).

The development of the High Temperature Gas-cooled Reactor (HTGR), which can supply heat at high temperatures (750-950°C), has increased the interest in the applications of nuclear process heat to various industrial sectors. Hydrogen is a synthetic, clean fuel which appears to be the most suitable as an energy carrier for such applications. In this article the possible processes of hydrogen production are described, subdivided in two categories: open cycle (using water, carbon, or hydrocarbons, as raw materials and heat) and closed cycle (using water and heat). The possibility of using nuclear heat in these hydrogen production processes is considered; a general arrangement of a modified HTGR reactor for steam reforming of methane is shown. Coal gasification is also considered as an open cycle. Lastly, the thermochemical decomposition of water, and its potential, are examined as a possible new method for hydrogen production from nuclear heat. (auth)

5363 NUCLEAR-REACTOR POWER-GENERATING PLANT. Cook, R. K.; George, B. V. (to British Nuclear Design and Construction Ltd.). British Patent 1,368,954/B/. Oct 1974. Filed date 28 Aug 1970. 8p.

In order to cope with peak demands for electric power there is an increasing requirement for nuclear power stations to have auxiliary generating capacity over and above the normal maximum continuous rating of the station. Such auxiliary capacity can be provided by gas turbine or diesel powered plant, but it would be convenient to associate the auxiliary plant with the reactor. In the arrangement described an auxiliary boiler is provided, of lower capacity than the main boiler, heated by the reactor, together with at least one auxiliary steam turbine. Various alternative plant arrangements are described. (UK)

5364 NUCLEAR REACTORS. Cook, R. K.; Tidmarsh, J. J. (to British Nuclear Design and Construction Ltd.). British Patent 1,373,493/B/. 13 Nov 1974. Filed date 7 Jan 1971. 6p.

In some types of reactors there is a requirement for a thermal shield of neutron absorbing material at the periphery of the core in order to reduce heating of a concrete pressure vessel surrounding the core. Shields have been proposed that take the form of solid material, such as plates of B steel, located between the core and the pressure vessel, and mounted on supporting structures. Such structures are costly, however, and necessitate enlargement of the pressure vessel. In the scheme described the reactor core includes a number of parallel columns of moderator material, and a ring of the columns located at or near the periphery of the core contains inclusions of neutron absorbing material, forming a thermal shield surrounding the columns located within the ring. Where the core comprises columns that contain fissile material, surrounded by reflector columns containing no fissile material, the reflector columns may comprise the thermal shield. The columns constituting the thermal shield are preferably provided with coolant channels. Various alternative arrangements are described. (UK)

5365 HIGH TEMPERATURE REACTOR. Insch, G. M. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). J. Inst. Nucl. Eng.; 16: No. 1, 3-14(Jan 1975).

A description is given of the high temperature gas cooled reactor (HTR) system under the following headings: introduction; design; reactor general arrangement; fuel elements and fuel cycle; graphite stack; control rods, shutdown systems, and refuelling pattern; refuelling systems; gas and steam systems; main boilers; auxiliary boilers; main gas circulators; auxiliary circulators;

thermal insulation; siting and safety; and operation and maintenance. (UK)

5366 IN-CORE FUEL MANAGEMENT FOR HIGH TEMPERATURE REACTORS. Day, J. W.; Linder, C.; Vaughan, R. I. (Central Electricity Generating Board, London). J. Inst. Nucl. Eng.; 16: No. 1, 18-23(Jan 1975).

An introduction is first given describing the features of the High Temperature Gas Cooled Graphite Moderated Reactor as under development in UK, USA and Germany, followed by discussion of fuel management under the following headings: core configuration and basic features of fuel management; reactivity control; constraints on fuel operating conditions; and power distribution with the reactor. (UK)

5367 REFUELLING OF NUCLEAR REACTORS. Hosegood, S. B. (to United Kingdom Atomic Energy Authority). British Patent 1,373,677/B/. 13 Nov 1974. Filed date 29 Mar 1972. 7p.

Reference is made to the on-load refuelling of nuclear reactors. It is stated that whereas the increased availability of a reactor refuelled on-load is highly desirable it has only been attained by introducing a degree of complexity which can introduce a risk of malfunction. Considerable difficulties may also be encountered in handling the spent fuel, and it is difficult to ensure adequate safety standards, particularly under emergency conditions. In the system described the reactor core comprises a number of interchangeable moderator units only some of which contain fuel. The blocks devoid of fuel are arranged at opposite faces of the core, and access to the core is by way of one of these faces. Two layers of these blocks may be located at one face and a single layer at the opposite face. The moderated units are divided into a first group comprising units containing fuel and a second group comprising units devoid of fuel. Sufficient units of the first group are provided for criticality under operating conditions, and a double row of units of the second group is located on one face of the core. The reactor is operated until an addition of fuel is required, and then second group units of the innermost row are progressively replaced with new first group units. This arrangement is claimed to lessen the hazards and difficulties associated with on-load handling of irradiated fuel. (UK)

5368 FUEL ELEMENT ASSEMBLIES. Statham, E. (to United Kingdom Atomic Energy Authority). British Patent 1,373,253. 6 Nov 1974. Filed date 28 Mar 1972. 5p.

Reference is made to fuel element assemblies for high temperature gas cooled reactors. Disadvantages of conventional designs are stated, the chief of which is cost of graphite tubes. The assembly described comprises a prismatic block of moderating material having fuel-containing bores, with interstitial coolant passages extending parallel to the bores. The fuel comprises stacked annular compacts that line the bores and provide a coolant flow passage through each bore and stack of compacts. This arrangement avoids the need for an outer sheath, adequate cooling being provided by coolant flow through the central flow passage through the fuel and the interstitial passages. An inner sheath may be provided for lining the coolant flow passage through the fuel, although this is not always necessary. The annular fuel members may comprise compacts of UO_2 particles coated with pyrolytic graphite and supported in a matrix of phenolic resin and a graphite compound. (UK)

5369 STUDIES ON FLATTENING OF AXIAL TEMPERATURE DISTRIBUTION OF A FUEL ELEMENT AND OPTIMIZATION OF PUMPING POWER. Ichimiya, K.; Hasegawa, S. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering). Nucl. Eng. Des.; 31: No. 3, 363-370(1974).

For optimal design of a gas-cooled reactor, pumping power can be improved by flattening the axial temperature distribution of the fuel elements. The optimization of pumping power for a single fuel element with annular passage and uniform heat flux or pseudo-sinusoidal heat flux is examined first. When the dimensionless highest wall temperature θ_h is given, the optimal dimension of the channel at which pumping power becomes minimum may be obtained. Furthermore, axial temperature distribution of a single fuel element can be flattened by varying the cross-sectional area of the coolant passage. The pumping power can be less than the least pumping power of a straight annulus. (auth)

5370 APPARATUS FOR MEASURING GASES FROM IRRADIATED FUEL PARTICLES. Lindemer, T. B.; Pearson, R. L. (Oak Ridge National Lab., Tenn. (USA)). J. Nucl. Mater.; 55: No. 3, 359-361(Mar 1975).

An apparatus is described that has been developed to measure the amounts of non-reactive gases, such as krypton and xenon, and reactive gases such as carbon monoxide contained in irradiated, carbon-coated oxide fuel particles used for the high-temperature gas-cooled reactor (HTGR). Such measurements are needed for the design and the performance analyses of the fuel particles. The measurement of primary interest is the amount of carbon monoxide as a function of temperature and number of fissions. (auth)

5371 BACK FLOW CHARACTERISTICS OF TURBINE CASCADES. Bammert, K.; Zehner, P. (Technische Univ. Hannover (F. R. Germany). Inst. fuer Stroemungsmaschinen). Atomkernenergie; 24: No. 4, 225-232(1974).

Fault analyses of nuclear plants with High Temperature Reactor and gas turbine in direct cycle as well as of Natural Gas Liquefaction plants (LNG-plants) showed the possibility of back flow through the turbo machines of some proposed systems in the case of an accident. As there was no knowledge about the characteristics of the cascades of turbo machines in the case of back flow, extensive tests were carried out in cascade wind tunnels. On the basis of the test results equations have been developed which permit the calculation of the back flow characteristics of standard made turbine cascades independent of geometric and aerodynamic parameters. Moreover, there is explained a hodograph method for approximate calculation of back flow characteristics for turbine or compressor cascades consisting of slender, slightly cambered profiles. The characteristics were applied in a turbine characteristic calculation at mean section and compared with results of tests on a 4-stage air turbine with blocked up rotor in the case of back flow. (auth)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstracts 5361 and 5727.

5372 (BARC/I-235) STRESS ANALYSIS OF DIAPHRAGM SUPPORT OF CALANDRIA-ENDSHIELD COMBINATION FOR NARORA ATOMIC POWER STATION. Kakodkar, A. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 13p. INIS.

Instead of using support rods to support the calandria and end shields separately, diaphragm supports are to be used to support the calandria-end shield combination in the power reactors of the Narora Atomic Power Station. This design is expected to simplify some of the alignment problems and to give a better structure for the seismic conditions. The diaphragm, in addition to its function as a support, is to accommodate the axial and radial expansion in a stable manner without generating excessive stresses within itself. The results of the theoretical investigation of this problem are presented taking into consideration stresses due to weight and thermal displacements only. Stresses due to weight on the diaphragm were found to be negligible. A scheme of anchoring the diaphragms to obtain the required stress on O. D. of .005 is suggested. The optimum thickness of the diaphragm should lie between 0.6" and 0.8". (INIS)

5373 (CONF-731218-P1, pp 405-414) OPERATING EXPERIENCE OF THE SGHWR IODINE SORPTION SYSTEM. Clifton, J. J. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The prototype Steam Generating Heavy Water Reactor currently operated by the UKAEA at Winfrith in Dorset has two large ventilation clean-up plants as part of the normal operating and post-accident filtration system. Each clean-up plant is capable of dealing with 4,600 litres of air per second. A clean-up plant consists of particulate filters and a bed containing 2,600 kg of charcoal which has been impregnated with chemicals to improve the retention of methyl iodide at high humidity. The performance of the charcoal is tested at routine intervals with radioactive methyl iodide. The tests are carried out in-situ at ambient humidities in the range 60 to 70% and in the laboratory at high (>98%) humidity. The design and layout of the SGHWR filter units, the method of testing and the operational test experience, and mechanical performance during six years of continuous operation are described. Included is a brief description of the tests carried out on iodine filtration units installed in the extract ventilation system of a "hot cell" facility. (auth)

5374 (ZJE-155) STARTING OF A-1 NUCLEAR POWER PLANT. Cernik, P. (Skoda, Plzen (Czechoslovakia)). 1974. 13p. Dep. NTIS (US Sales Only) $4.00.

Startup experience with the BOHUNICE A-1 reactor at the Skoda Works, Plzen, Czechoslovakia is reported. Power was

increased slowly and accompanied by many measurements, which were processed as quickly as possible. Radiation heating was several times greater than calculated in the design. Corrosion and erosion were determined in the heavy water pressure vessel. Except for the reactor physics, this corrosion was the most important problem. At 25 percent of full power, the power could be controlled to better than ±0.4 percent. Jumps in power of 10 percent were compensated for by the control system in less than 1.9 seconds. (LTN)

5375 MECHANISM AND METHOD FOR POSITIONING A MACHINE NOZZLE. Janusz, S. A. (to Canadian General Electric Co. Ltd.). British Patent 1,368,837/B/. 2 Oct 1974. Filed date 9 Jun 1972. 7p.

A method is described for precisely positioning the nozzle of a nuclear reactor refuelling machine onto a fuel channel while the reactor is on-load, including the provision of an attitude sensing mechanism and means for controlling the homing. The mechanism is compressed air operated. (UK)

5376 NEUTRON FLUX MAPPING IN THE REACTOR KS-150 WITH IN-CORE SELF-POWERED DETECTORS. Rana, S. B. Jad. Energ.; 21: No. 3, 86-90(Mar 1975).

In-core neutron flux measurements in the reactor KS-150 utilizing mapping fuel elements with rhodium self-powered detectors of type DPZ-1 are described. The measurement system and method of evaluating detector signals using Fourier analysis are described. An advantage factor of the axial neutron flux distribution for thermal power production is introduced. Neutron flux distributions during the second period of power commissioning and preparation of further extension of measurements are reported. (18 references) (auth)

5377 NUCLEAR CALCULATION METHODS FOR D_2O-MODERATED REACTORS. A Comparison of Theory and Experiment for a Gas-Cooled Prototype. Gruen, A.; Raum, H. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Atomkernenergie; 24: No. 4, 251-258(1974). (In German).

The gas-cooled heavy-water moderated reactor of the nuclear power plant Niederaichbach (KKN)—shut down for economic reasons—is distinguished by a strongly heterogeneous construction of the lattice cell as well as the core. The zero power measurements carried out at the initial start-up of this test power plant are therefore especially suited for checking the theoretical methods applied to heavy water reactors. The comparison of measured reactivities and flux distributions with the corresponding calculated values shows that collision probability methods, used for spectrum and lattice calculations, and Feinberg's and Galanin's heterogeneous theory as well as diffusion theory, used for core calculations, are able to describe reliably even so complicated core configurations as the KKN-reactor. Hence these methods are certainly also suitable for more simply constructed heavy water reactors the fuel management. (auth)

Power Reactors, Breeding

Refer also to abstracts 3306, 5325, 5326, 5598, 5602, 5603, 5615, 5617, 5634, and 5644.

5378 (ANL-CT-75-30) SODIUM IMMERSIBLE HIGH TEMPERATURE MICROPHONE DESIGN DESCRIPTION. Gavin, A. P.; Anderson, T. T.; Janicek, J. J. (Argonne National Lab., Ill. (USA)). Feb 1975. 131p. Dep. NTIS $9.75.

Argonne National Laboratory has developed a rugged high-temperature (HT) microphone for use as a sodium-immersed acoustic monitor in Liquid Metal Fast Breeder Reactors (LMFBRs). Microphones of this design have been extensively tested in room temperature water, in air up to 1200°F, and in sodium up to 1200°F. They have been successfully installed and employed as acoustic monitors in several operating liquid metal systems. The design, construction sequence, calibration, and testing of these microphones are described. 6 references. (auth)

5379 (CEA-CONF-2850) FRENCH PROGRAM OF ADVANCED REACTOR: REVIEW PAPER. d'Orval, C. C.; Brisbois, J.; Schwartz, J. P.; Mougniot, J. C. (CEA, 75-Paris (France)). 1974. 18p. (CONF-740903-17). Dep. NTIS (US Sales Only) $4.00.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

The French development programs for LMFBR, HTGR, PWR, and BWR reactors are reviewed. (DCC)

5380 (CEA-CONF-2889) CONTROL ROD STUDIES IN THE CEA FAST REACTOR PHYSICS PROGRAMME. Hammer, P.; Barre, J. Y.; Bouget, Y. H.; Fabianelli, R.; Filippi, G.; Mougniot, J. C.; Sicard, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Div. d'Etude et de Developpement des Reacteurs). 1974. 30p. (CONF-740903-19). Dep. NTIS (US Sales Only) $4.50.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

A description is given of experimental and theoretical work conducted at CEA to support mixed oxide LMFBR design calculations involving control rod problems. The standard calculational methods used are described, and the results obtained are compared with experiments performed to investigate reactivity worths of B4C or diluent (Na-Stainless Steel) rods, power distribution perturbations, and γ-heating. The consequences of these comparisons for PHENIX critical mass prediction and start-up measurements are given. Future developments of the program foreseen for SUPER-PHENIX are briefly described. (auth)

5381 (CEA-CONF-2890) ANALYSIS OF THE INITIAL PHENIX THERMAL BALANCES. Ginier; Gouriou; Kayser; Skok; Coulon. 1974. 9p. (In French). (CONF-740903-18). Dep. NTIS (US Sales Only) $4.00.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

Results obtained during preparation for nominal power operation of Phenix are presented. Studies of power and temperature distribution in the core are described, and comparisons are made with the predicted values. Evaluations and comparisons of thermal heat balances obtained in the core and in the cooling circuits are presented. (auth)

5382 (CEA-CONF-2894) TESTS CARRIED OUT ON THE PHENIX STEAM GENERATOR LEAK DETECTION SYSTEMS. Cambillard, E.; LaCroix, A.; Langlois, G.; Viala, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)). 1974. 21p. (In French). (CONF-741085-6). Dep. NTIS (US Sales Only) $4.25.

From symposium on steam generators for liquid metal fast breeder reactors; Bensberg, F. R. Germany (14 Oct 1974).

The Phenix secondary circuits are provided with systems that measure the hydrogen concentration in sodium for the detection of possible water leaks in steam generators and the location of a faulty module. A measurement device consists of a detector with nickel membranes of 0.3 mm wall thickness, an ion pump with a 200 l/s flow rate, a quadrupole mass spectrometer and a calibrated hydrogen leak. The temperature correction is made automatically. The main tests carried out on the leak detection systems are reported. (auth)

5383 (CEA-R-4650) ANALOGIC MEASUREMENT OF THE REACTIVITY. Applications for the Control and the Safety of Reactors. Plaige, Y.; Vaux, C.; Baillet, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France)). Mar 1975. 31p. (In French). Dep. NTIS (US Sales Only) $4.75.

The analog reactivity meter is based on the simulation of reactor kinetics equations. It is composed mainly of a simulation network and an electronic divider circuit. A neutron flux signal is applied at the input. Reactivity meters have been utilized for several years for the measurement of reactor physical data (rod efficiency, poisoning, temperature coefficient etc). Recently they were included in the control panels for high level safety of fast neutron reactors. A reactivity meter is proposed which can be used during the start up operations in spite of the difficulty presented by the initial antireactivity setting. A new instrument able to function over the entire reactor control range is now being designed. (auth)

5384 (CONF-741017-29) MIXED CARBIDE FUEL PIN PERFORMANCE ANALYSIS. Boltax, A.; Nayak, U. P.; Skalka, R. J.; Biancheria, A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Advanced Reactors Div.). 1974. Contract AT(11-1)-3045. 8p. Dep. NTIS $4.00.

From meeting of the American Nuclear Society; Washington, District of Columbia, USA (27 Oct 1974).

Analytical studies of mixed carbide fuel performance provide the basis for an understanding of the available irradiation data as well as aid in the design of the additional reactor experiments required to develop a mixed carbide fuel system for commercial LMFBR's. (auth)

5385 (COO-2467-1) THREE-DIMENSIONAL LMFBR SHIELDING DESIGN AND ANALYSIS CODE. Quarterly Report, September 1, 1974-November 30, 1974. Poncelet, C. G.; Bucholz, J. A. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Nuclear Engineering). 1974. Contract AT(11-1)-2467. 67p. Dep. NTIS $6.50.

The development of a design-oriented three-dimensional transport method for shielding calculations is described. The method,

as originally suggested by Wagner, uses 14 angular directions, or rays, within an array of uniform cubical mesh blocks, with the rays continuous at block interfaces and passing through the centers of the blocks. The integral transport equation is solved analytically along the rays within a block, with outgoing rays becoming incoming rays for adjacent blocks. Extensions of the method are described to include full anisotropic scattering based on integrated ray-to-ray scattering probabilities, variable mesh capability, and generalized boundary conditions including vacuum, reflection with arbitrary albedo, periodic, and specified source. A computer code, TRANS3, has been developed to incorporate the method and its various extensions, and the program logic is described. The code has multigroup capability and will perform fixed source or eigenvalue calculations. Appropriate use of the reflective boundary condition permits use of the code in one- or two-dimensional geometries. The selection of efficient spatial mesh sweeping algorithms and of efficient iterative schemes in the solution of the ray equations is summarized. (5 references) (auth)

5386 (EIR-270) TRANSMUTATION OF FISSION PRODUCTS (^{137}Cs, ^{90}Sr) IN A LIQUID-FUELED, FAST FISSION REACTOR WITH THERMAL COLUMN. Taube, M.; Ligou, J.; Bucher, K. H. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb 1975. 43p. Dep. NTIS (US Sales Only) $5.25.

The possibilities for the transmutation of cesium-137 and strontium-90 in a high-flux fast reactor with molten plutonium chlorides and with thermal column are discussed. The effective half life of Cs-137 could be decreased from 30 years to 4-5 years, and for Sr-90 to 2-3 years. (auth)

5387 (EURFNR-1190) INCREASES IN THE CENTERLINE TEMPERATURE OF MIXED OXIDE FAST REACTOR FUEL PINS AS A RESULT OF URANIUM/PLUTONIUM REDISTRIBUTION. Bober, M.; Schumacher, G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik) Apr 1974. Translation of KFK-1904. 46p. Dep. NTIS $4.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Results of post irradiation examinations of redistribution of uranium and plutonium in fast reactor mixed oxide fuel pins are reviewed. Redistribution by evaporation-condensation processes clearly depends on stoichiometry and only to a less degree on power rating and burnup. It mainly develops in the first stage of fuel restructuring. At the central void the plutonium enrichment yields up to 170% of the average concentration. This causes an increase in central temperature up to 150°C. The enrichment due to redistribution by thermal diffusion is mainly determined by power rating and burnup. It still grows until the irradiation has been finished. At a power rating of 500 W/cm the enrichment of plutonium yields up to 140% which increases the central temperature up to 100°C. 31 references. (auth)

5388 (EURFNR-1235) CONTROL ROD WORTH AND POWER DISTRIBUTION MEASUREMENTS IN THE SNR MOCK-UP SNEAK ASSEMBLY 9A. Pinter, M.; Boehme, R.; Durance, G.; Fehsenfeld, P.; Giese, H.; Pilate, S.; Wehmann, U. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Nov 1974. 92p. (KFK-2077). Dep. NTIS (US Sales Only) $5.45.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The series of assemblies which were built for investigations with regard to the SNR was continued with the Assembly SNEAK-9A. This assembly was a mock up of the SNR with two core zones in the radial direction. The fuel material was enriched uranium. The main objectives were control rod worths and power distribution measurements. Most of the calculations were performed with the group diffusion method using 4 energy groups. The most important result is a general underestimate of the control rod worths. The power distribution shows in general an overestimate in the upper, and an underestimate in the lower core half. This effect may also be related to the underestimate of the control rod worths. (auth)

5389 (HEDL-TME-74-4(Vol.4)) HEDL QUARTERLY TECHNICAL REPORT, OCTOBER–DECEMBER 1974. Volume 4. Engineering and Development. Noordhoff, B. H.; Weber, S. A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1975. Contract AT(45-1)-2170. 153p. AT.

Information is presented concerning the testing of Clinch River Breeder Reactor and FFTF components and systems, nondestructive testing engineering, development of FFTF instrumentation and data processing systems, and FFTF design specifications. (JWR)

5390 (KFK-2110) STATUS AND FURTHER DEVELOPMENT TARGETS OF THE SNR FUEL ELEMENT DEVELOPMENT. Karsten, G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Projekt Schneller Brueter). Nov 1974. 16p. (In German). Dep. NTIS (US Sales Only) $4.00.

Within the scope of the fuel element development program for the fast breeder reactor SNR 300, 500 fuel pins have been irradiated since 1964 with 250 of them in the fast flux. The result is that the maximum nominal target burnup of 90.000 MWd/t of the SNR 300 Mk Ia possibly can be reached. The main problems, which arise from the clad swelling and internal corrosion, can be met by special pretreatments of the austenitic stainless steel (1.4970) and a fuel stoichiometry of 1.97. Beyond this target either material property improvements have to be made or burnup reductions have to be accepted. These remaining questions can be answered by the use of the SNR 300 as a test reactor. A further target is the development of a carbide fuel element. This will be very effective in a high power breeder reactor because of its low fissile inventory and high breeding gain under the aspects of saving uranium resources in the future. This development program will also be finalized in the SNR 300. (auth)

5391 (KFK-EXT-6/65-7) CORROSION PROBLEMS IN FAST SODIUM COOLED REACTORS. Borgstedt, H. U. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Feb 1975. 27p. Dep. NTIS (US Sales Only) $4.50.

A survey of corrosion problems in the components of a fast sodium-cooled reactor due to the use of sodium as a coolant is given. (auth)

5392 (LA-5881-PR) EXAMINATION OF FAST REACTOR FUELS, FBR ANALYTICAL QUALITY ASSURANCE STANDARDS AND METHODS, AND ANALYTICAL METHODS DEVELOPMENT-IRRADIATION TESTS. Quarterly Report, October 1–December 31, 1974. Baker, R. D. (comp.). (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1975. Contract W-7405-eng-36. 12p. Dep. NTIS $4.00.

The development tests and examination equipment and new analytical chemistry techniques for examining irradiated LMFBR fuel pins are described. Quality assurance requirements for FFTF materials and components are presented. The development of a fuel burnup measurement method and the development of a fuel composition determination method are reviewed. (DCC)

5393 (PB-237310) EUROPEAN SODIUM CAVITATION RESEARCH: STATE OF ART. Hammitt, F. G. (Michigan Univ., Ann Arbor (USA). Dept. of Mechanical Engineering). Oct 1974. 22p. NTIS $3.25.

The present state-of-the-art and probable future course of sodium cavitation research is reviewed with particular application to fast breeder reactors programs in Europe and Britain. The information has been gleaned to a large extent from conversations and other unpublished documentation resulting from the author's visits during the past summer to atomic energy laboratories in France, England, and Holland. The present report will cover the pertinent work in all these countries, and will list published references where possible. (auth)

5394 (R/M/N-734) ULTRASONIC WAVEGUIDES FOR USE IN SODIUM COOLED FAST REACTORS. Hepworth, J. K.; Burns, W.; Varey, R. H. (Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs.). Jan 1974. 19p. Dep. NTIS (US Sales Only) $4.25.

The attenuation and distortion of ultrasonic signals have been measured in solid, liquid filled and multi-wire waveguides (radius up to 25 mm, length up to 1.2 m) at a frequency of 2.5 MHz. It is concluded that over the lengths required for use in a fast reactor, liquid filled waveguides potentially produce considerably less attenuation than solid rods but that multi-wire waveguides appear most promising in terms of low distortion and physical flexibility in use. (auth)

5395 (RT/ING-74-17) BOILING HEAT TRANSFER IN LMFBR STEAM GENERATORS. Campolunghi, F.; Cumo, M.; Ferrari, C.; Vaccaro, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1974. 15p. INIS.

The prediction of the surface heat flux in the boiling region of sodium-heated once-through steam generators requires the employ of forced-convection boiling heat transfer correlations. On one side, the overall extension of the boiling region, i.e., from the point of zero-quality to the point of burn-out or dry-out covers a considerable extension of the whole length, so becoming a determining factor in the thermal design and in the capital costs, on the other a very great special does exist among the prediction of the available correlations. So an extensive, experimental research

has been performed in full scale, employing long and vertical tubular ducts (L = 11 m; D = 12 mm), uniformly heated by Joule effect, in a pressure range from 60 to 160 kg/cm^2. The available experimental data have been tested systematically against well known correlations to deduce useful information for the thermal design. (INIS)

5396 (SRD-R-34) LOCAL BOILING IN FAST REACTOR SUB-ASSEMBLY GEOMETRY. Brook, A. J. (UKAEA Safety and Reliability Directorate, Culcheth). 1974. 99p. Dep. NTIS (US Sales Only) $5.45.

A theoretical model has been developed to represent the growth and collapse of sodium vapor bubbles from a locally superheated region into sub-cooled surroundings, in the geometry of a fast reactor subassembly. The model and some of the results obtained from it are described. Unlike other models, in which saturation conditions are assumed to apply, the pressure in the vapor is defined by a kinetic theory type of approach, and is shown to lie essentially at the level at which evaporation and condensation rates to and from the fuel pins and the vapor/liquid interface are matched. This approach enables some account to be crudely taken of the effects of noncondensable gas which may be present in small quantities and which may be expected to inhibit the condensation process. The effects are studied of changes in the major parameters, such as the size of the superheated region, the form of the temperature profile around it, superheat, sub-cooling, condensation coefficient, pressure, etc. Results are presented for bubbles growing from regions of superheated coolant and from those generated within a local blockage of fissile material. Although extension into axial growth along the subassembly cannot be represented rigorously, pessimistic simplifications can be made which suggest that flow instability and the propagation from local to bulk boiling seem unlikely to occur. 47 references. (auth)

5397 (TI-001-130-025) TRANSWRAP: A COMPRESSIBLE HYDRODYNAMIC CODE FOR LARGE-LEAK SODIUM/WATER REACTION ANALYSIS. Bell, C. R.; Heisler, M. P. (Atomics International Div., Canoga Park, Calif. (USA)). 5 Feb 1973. 105p. Dep. NTIS $8.25.

The analysis of the effects of a sodium-water reaction in a steam generator consists of three main parts which are interdependent. First, there is the analysis of the actual sodium-water reaction which produces the pressure transient. The reaction zone which develops is the connecting link to the other two parts of the analysis. These involve the transient response of the secondary sodium loop which must accommodate the expanding hydrogen gas bubble and the transient response of the H_2O system which feeds the reaction. Each of these portions of the total analysis is discussed briefly. (auth)

5398 (WARD-3045-T-1-2) SODIUM TECHNOLOGY PROGRAM. Progress Report for the Period Ending January 31, 1972. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Mar 1972. Contract AT(11-1)-3045. 78p. AT.

Progress is reported on wear and bearing testing, self-welding evaluation, and components materials compatibility for LMFBR materials. Sodium compatibility of FFTF duct load pad materials is analyzed. Performance testing of on-line oxygen meters is reviewed. (DCC)

5399 (WARD-3045-T-1-3) SODIUM TECHNOLOGY PROGRAM. Progress Report for the Period Ending April 30, 1972. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jul 1972. Contract AT(11-1)-3045. 135p. AT.

Progress is reported on wear and bearing testing, self-welding evaluation, and components materials compatibility for LMFBR materials. Sodium compatibility of FFTF duct load pad materials is analyzed. Performance testing of on-line oxygen meters is reviewed. (DCC)

5400 LIQUID METAL FAST BREEDER REACTOR DEMONSTRATION PLANT. Kenney, J. (Westinghouse Advanced Reactors Div., Madison, PA). pp 85-88 of Energy and the Environment. Buonicore, A. J. (Ed.). Dayton, OH; American Inst. of Chemical Engineers (1974).

From 1st annual AIChE conference on energy and the environment; Oxford, Ohio, USA (25 Oct 1973). See CONF-7310101-.

The development program for the Clinch River Breeder Reactor is reviewed. Design objectives and operating parameters are discussed. (DCC)

5401 IRRADIATION SWELLING, CREEP AND THERMAL FATIGUE BEHAVIORS OF LMFBR PRESSURE VESSELS. Benjamin, M. M. (Iowa State Univ., Ames). J. Franklin Inst.; 299: No. 2, 127-146(Feb 1975).

The behaviors of irradiation swelling, irradiation creep and thermal-cycling fatigue induced by fast neutron fluence and developed in the LMFBR pressure vessels are analyzed on the basis of experimental data. From the interactions of the irradiation swelling, irradiation creep and thermal-cycling fatigue, the failure criterion for the design and safety surveillance of the pressure vessels can be expressed as a function of t, t/sub c/, N, N/sub f/, epsilon and epsilon/sub s/, where t is time, t/sub c/ is creep rupture time, N is number of cycles, N/sub f/ is number of cycles to failure, epsilon is strain, epsilon/sub s/ is swelling strain to failure, and a, b, c, u, v and w are parameters or constants. The tangential tensile strain produced by the irradiation creep, thermal-cycling fatigue and hydrostatic pressure of the liquid sodium coolant may be combined together with the irradiation swelling strain epsilon as a whole. The interrelationships between the behaviors of irradiation swelling, irradiation creep and thermal-cycling fatigue developed in the LMFBR pressure vessels are discussed. (auth)

5402 REDISTRIBUTION OF FUEL AND FISSION PRODUCTS IN IRRADIATED OXIDE FUEL PINS. Bramman, J. I.; Powell, H. J. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). J. Brit. Nucl. Energy Soc.; 14: No. 1, 63-75(Jan 1975).

A review is presented based largely on hitherto unpublished Dounreay data on the movement of fuel and fission products in fast reactor irradiated oxide fuel pins. The processes of redistribution are discussed in qualitative terms. Although extensive redistribution is commonly observed, none of the phenomena is likely to limit the use of oxide fuels in commercial fast reactor cores. (auth)

5403 THEORETICAL AND EXPERIMENTAL VALUES OF THE SODIUM VOID EFFECT FOR THE BN-350 REACTOR AND FOR THE MODEL OF THE BN-500 REACTOR. Tinka, I. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 21: No. 2, 41-43(Feb 1975). (In Czech).

The numerical results obtained on the basis of the perturbation theory in NRI Řež and their comparison with FEI Obninsk calculations and experimental data are presented. An analysis of the results for the BN-350 reactor from the point of view of discrepancy with experimental values has been partially performed. (8 references) (auth)

5404 NUCLEAR ENGINEERING AND ATOMIC POWER. Kohl, H. K.; Sarlos, G.; Seifritz, W. (Institut fuer Reaktorforschung Wuerenlingen, Switzerland). Neue Tech.; No. 9, 343-350 (1974). (In German).

The necessity of the introduction of Breeder Reactors results from the fuel shortage and from the presumed increase in fuel prices for light water reactors in the future. Without the introduction of breeder reactors the uranium mining and the needed separative work capacity would increase enormously. Good breeder reactors are able to extend the uranium and thorium reserves and to guarantee the fuel supply for a long time. At the moment the gas cooled fast reactor — which is in its development behind the sodium cooled fast reactor — seems to have a better breeding rate than the sodium cooled reactor. In the future, for a maximum independence the former provides a more favorable ratio of breeder to burner reactors. (auth)

5405 REACTOR VESSEL SEAL SERVICE FIXTURE. Ritz, W. C.; Otterman, G. E. (to United States Energy Research and Development Administration). US Patent 3,872,565. 25 Mar 1975. Filed Date 9 May 1974. 4p.

Apparatus for installing a seal in the head of a reactor vessel is described which comprises a fixture supporting the seal which automatically releases the seal when the fixture comes in contact with the head. (Official Gazette)

5406 ELECTROMAGNETIC SELF-EXCITATION IN THE LIQUID-METAL FAST BREEDER REACTOR. Pierson, E. S. (Argonne National Lab., IL). Nucl. Sci. Eng.; 57: No. 2, 155-163(Jun 1975).

The possibility of electromagnetic self-excitation of the fluid flow in liquid-metal fast breeder reactors has been predicted based on gross dimensions without consideration of the details of the flow. The flow in the reactor core cooling ducts is analyzed, and it is shown that self-excitation is not expected. Simplified field and flow patterns are assumed since the results of both experiments and the usual analytical techniques are not expected to be of practical value. (auth)

5407 COMPREHENSIVE EXPRESSION FOR THE DOUBLING TIME OF FAST BREEDER REACTORS. Hardie, R. W.; Little, W. W.; Omberg, R. P. (Hanford Engineering Development Lab., Richland, WA). Nucl. Technol.; 26: No. 1, 115-116(May 1975).

A wide range of expressions is currently used to calculate the doubling time of fast breeder reactors. These formulations often result in significantly different numerical values for the doubling time using the same reactor data. Since the treatment of out-of-reactor inventory and fuel cycle losses is usually responsible for

the differences, an expression for the doubling time accounting for these effects in a simple and logical manner is developed. (auth)

5408 MATCHING OF FUSION BREEDERS TO HEAVY-WATER REACTORS. LaVergne, G. (Hydro Quebec, Gentilly); Robinson, J. E.; Martel, J. G. Nucl. Technol.; 26: No. 1, 12-22 (May 1975).

The matching of D-T fusion breeders to heavy-water CANDU-type reactors has been studied using the transport code ANISN to evaluate the neutron transport and breeding characteristics of a low-power-gain fusion blanket. The fusion blanket consists of a niobium structure, natural lithium coolant, and a graphite reflector with 2- to 6-cm-thick zones of Th, ThO_2, or ThC situated between the first wall and the reflector. Total breeding ratios of 1.40 to 1.50 have been calculated. Using the calculated breeding ratios, a system period of less than 10 years is determined for proposed solid thorium fuels. The reaction rate ratio of fusion to fission is less than unity. (22 references) (auth)

5409 CORE-WIDE STATISTICAL EVALUATION OF THE EFFECT OF UNCERTAINTIES IN CLAD TEMPERATURE, MATERIAL PROPERTY DATA, AND BURNUP ON THE PROBABILITY OF LMFBR FUEL ROD FAILURE DUE TO CREEP RUPTURE. Atcheson, D. B.; Temme, M. I. (General Electric Co., Sunnyvale, Calif. (USA)). Nucl. Eng. Des.; 31: No. 3, 391-404(1974).

Rigorous treatment of the uncertainties inherent in LMFBR core component design requires the development of probabilistic design tools to analyze life-limiting loading mechanisms. One of these tools is a Monte Carlo simulation technique that has been developed to analyze sealed plenum fuel rods subject to fission gas-induced creep rupture. This Monte Carlo technique avoids the need for simplifying the forms of probability distributions and is able to correctly simulate the interaction of many random variables by including all such variables in the analysis. With the use of a biased sampling technique, sufficiently accurate predictions of the number of fission gas pressure-induced failures in the core are obtained in typical calculations for less than $50 ($500 without biasing) on the Honeywell 6000 computer. The application of the biasing technique to core-wide analysis provides a major new capability at a cost that allows routine design use. The PECS (probabilistic evaluations of clad stress) computer code, which employs these techniques, has been applied to study the significance of uncertainties in material properties, temperature, dimensions and burnup. The effect of thermal-hydraulic design optimization is investigated probabilistically to illustrate potential applications of the method. (auth)

5410 INCIPIENT AND NUCLEATE BOILING OF SODIUM. Schins, H. E. J. (Commission of the European Communities, Ispra (Italy). Div. of Technology). Atomkernenergie; 24: No. 4, 243-246(1974).

Wall temperature measurements of incipient and nucleate boiling of sodium are presented; incipient boiling temperatures were taken at the moment of bumping. Incipient boiling superheats can be accounted for if heterogeneous nuclei are postulated to appear in the heater surface cavities when a modified equation for homogeneous nucleation is satisfied. In this equation the energy necessary for the formation of a nucleus is corrected by a term 2×10^{-7}. It was found that superheat values of different authors correspond to different modification factors. An interpretation for these factors is given for conical cavities. Using the wall temperature at stable boiling, it was found that the dominant mouth radius of surface cavities was 0.07 mm. (auth)

Research, Test, and Experimental Reactors

Refer also to abstracts 3623, 5389, 5392, 5398, 5399, 5607, 5608, 5662, 5670, and 5765.

5411 (CONF-731218-P1, pp 503-509) EXPERIENCE WITH CHARCOAL FILTER SYSTEMS INSTALLED IN SEVERAL BUILDINGS AT THE RCN SITE. Stoute, J. R. D.; Groen, G. C. H. (Stichting Reactor Centrum Nederlands, Petten). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

The air cleaning systems on the R. C. N.-site are under supervision of the Health Physics Department. Experiences are described regarding the charcoal filters of the off-gas system of the HFR (pool-type research reactor), of the waste department, and of the isotope-production plant owned by Philips Duphar. The results of periodical tests are discussed, the tests being carried out with elemental iodine, methyliodide, and with the gaseous effluents normally present in the ventilation ducts of the isotope-production plant. (auth)

5412 (EUR-5080) SORA: SCIENTIFIC-EXPERIMENTAL PROGRAMME. Fraysse, G. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 367p. INIS.

Revised edition of ISPRA-report 1560.

For many years, the Joint Research Centre has devoted a considerable effort to the study of a fast pulsed reactor "SORA." The report deals with the utilization of this pulsed reactor in the following fields: diffraction, inelastic scattering, polarized neutrons, neutron cross-section measurements, nuclear physics, and radiation damage. Many experimental facilities are proposed and a detailed cost evaluation is provided for each facility. An important chapter concerning the moderators is also included. (INIS)

5413 (IBK-1285) THERMOLUMINESCENCE DOSIMETRY OF GAMMA RADIATION AT THE REACTOR RA VINCA. Prokic, M. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1974. 16p. (In Serbian). INIS.

A description is given of procedures and measurements of the gamma radiation dose at horizontal and vertical experimental channels and in the thermal column of the Reactor RA, Vinca. Thermoluminescent phosphors were used. Gamma ray exposures were measured at two positions – in the air and on the surface of the bottle with the tissue equivalent solution. The gamma ray exposure at the surface of the bottle was about 2.3 greater than the value measured in air. Corrections for the neutron influence on the phosphors were carried out on the basis of the known values for the corresponding neutron responses. (INIS)

5414 (LFEN-160-g) EXPERIMENTAL DETERMINATION OF THE ZERO POWER TRANSFER FUNCTION OF THE PORTUGUESE RESEARCH REACTOR. Oliveira, J. M. C.; Veiga, C. A. M. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). 1973. 9p. (In Portuguese). INIS.

The zero power transfer function of the Portuguese Research Reactor (RPI) was measured using the reactivity oscillation technique over the frequency range of 5.10^{-3} Hz to 65 Hz. The experimental set-up and measurement technique used are described, as well as the numerical handling of the data. The reactivity oscillator designed for the present experiment had good stability at the frequencies studied and the technique used in the detection and analysis of the reactor output proved to be very efficient. The results obtained are compared to the point-reactor kinetics model and the effect of the space harmonics on reactor dynamics is observed. From the measured transfer function a prompt neutron generation time of $\Lambda = (56 \pm 2) \times 10^{-6}$sec is obtained with an effective delayed neutron fraction $\beta_e = (760 \pm 26) \times 10^{-5}$. (INIS)

5415 (LFEN-NI.-62-a) HEAVY WATER LATTICES. Jorge, H. M. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). 1970. 5p. (In Portuguese). INIS.

UO_2(nat)/D_2O and U(nat)/D_2O lattices are calculated by a Fortran II code written for the IBM 1620. In both cases the fuel is considered in the form of rods (1.00 to 4.00 cm diameter) and clusters of seven rods (0.80 to 2.00 cm diameter). The results are presented in diagrams and drawings. (INIS)

5416 (LFEN-NI.-63-a) URDO: A FORTRAN II COMPUTER CODE LFEN-FR8-COMPUTATION OF HEAVY WATER LATTICES. Jorge, H. M. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). 1970. 33p. (In Portuguese). INIS.

URDO is a FORTRAN-II code written for the IBM 1620, to compute heavy water moderated, natural uranium dioxide or uranium metal fueled-lattices. The code, based upon a one-group NAUDET formalism, uses the four factor formula to compute the infinite multiplication factor. Two distinct fuel element geometries are handled: (1) single rods and (2) clusters of seven rods. The report contains a brief discussion of the formalism and a listing of the input data format. A listing of the source statements and a sample problem are also included. (INIS)

5417 (NIIAR-P-211) RADIOACTIVITY IN THE BOR-60 REACTOR COOLING SYSTEMS WITH SEALED FUEL ELEMENTS. Gryazev, V. M.; Konyashov, V. V.; Polyakov, V. I.; Krasnoyarov, N. V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1973. 15p. (In Russian). INIS.

The values of ^{24}Na, ^{23}Ne, and ^{20}F in the sodium coolant were determined. The long-lived components ^{22}Na and ^{110m}Ag were determined. In deposits on the surface of the piping and particularly on the cold parts of the loop, the corrosion-originated isotope ^{60}Co and ^{54}Mn were present. The radioactivity in the gaseous voids was determined by the activation of Ar and the emission of ^{23}Ne and gaseous fission products from the Na. It

was shown that the mean residence time of all inert gases in the coolant is 8 hrs. (tr-auth)

5418 (WANL-TME-604) ASSEMBLY PROCEDURES FOR THE PREASSEMBLY EXPERIMENTAL REACTOR (PAX). Aducci, S.; Polinak, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1964. 163p. Dep. NTIS $11.25.

Declassified 11 Sep 1973.

The general procedures to be followed in assembling the Reactor for Pre-Assembly Experiment–PAX (ND 10201) are described. The sequence of operations to be followed during assembly is specified and additional documentation and other relevant supplementary information required is identified. (auth)

5419 DOSE RATE STABILITY OF A BIOLOGICAL IRRADIATION FACILITY AT A THERMAL REACTOR. Zarand, P. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Biochim. Biophys. Acad. Sci. Hung.; 7: No. 2, 187-188(1972).

The dose rate stability of the biological irradiation facility at the Budapest WWR-C Reactor was studied over full cycles of 53 or 115 hours. Results show that the dose rate stability is quite satisfactory for biological experiments. (JWR)

5420 DIRECT MEASUREMENT OF REACTIVITY FOR CONTROL ROD CALIBRATION. Emslie, W. A.; Park, G. L.; Wilkinson, B. W. pp 431-434 of Pittsburgh, PA; Instrument Society of America (1974).

From 20th international instrumentation symposium; Albuquerque, NM (21 May 1974).

A simple inexpensive instrument for measuring the reactivity of a low-power nuclear reactor is described. The readout is directly in cents on a standard meter movement and the instrument is compactly designed using readily-available electronic modules. It is in regular use on the Michigan State University TRIGA reactor. (auth)

5421 TIME-RESOLVED NEUTRON RADIOGRAPHY USING A FAST PULSE REACTOR. Aseltine, C. L.; Strich, R. A. (Ballistic Research Labs., Aberdeen Proving Ground, MD). Nucl. Technol.; 26: No. 1, 107-114(May 1975).

The feasibility of using a fast pulse reactor as a neutron source in the production of time-resolved neutron radiographs has been demonstrated at the U. S. Army Pulse Radiation Facility. The radiographs were obtained using the transfer radiographic method. Pulses with a full width at half maximum of 50 mu sec and 1.2×10^{17} fissions were utilized to obtain time-resolved radiographs of objects moving at speeds up to 76 m/sec. Investigation of double images, observed in radiographs of test objects moving within this speed range, suggests a method of producing "motion pictures" of these objects using one reactor pulse and a suitable stack of detection foils. Resolution of objects moving at speeds greater than 76 m/sec can be obtained by reducing source exposure time to a lower limit of 1 mu sec through employment of electronic gating and image intensification techniques. (11 references) (auth)

5422 PSEUDORANDOM MULTIFREQUENCY BINARY SEQUENCE TESTING AND STATE VARIABLE, FREQUENCY RESPONSE ANALYSIS OF A FLUX-TRAP TYPE REACTOR SYSTEM. Gist, W. J.; Bull, S. R.; Partain, C. L. (Univ. of Missouri, Columbia). Nucl. Sci. Eng.; 57: No. 2, 97-116(Jun 1975).

The kinetics of a flux-trap cylindrical reactor system were studied both theoretically and experimentally. A state-variable approach was used to develop a twenty-fourth-order model describing neutron and temperature kinetics in 14 regional system components. The modified Mikhailov method was used to determine the stability of the model. The reactor system was studied using step testing and pseudorandom multifrequency binary sequence testing procedures with a small-computer based instrumentation system. Measurements were made at powers of 1, 2.5, and 4 MW. The frequency response analysis of the system model compared favorably with experimental observations. (auth)

5423 PROVIDING RADIATION PROTECTION IN THE DESIGNING AND OPERATION OF CRITICAL NUCLEAR ASSEMBLIES. Arkhangel'skaya, I. G. Gig. Tr. Prof. Zabol.; No. 12, 41-42(1974). (In Russian).

The construction of any nuclear reactor is preceded by the simulation of its active zones on critical nuclear assemblies. Such an assembly corresponds to a full-scale reactor with respect to the composition of the active zones, the type of fuel elements, and the dimensions of the critical assembly, but it operates at low power on the order of several watts, with a brief peak to several hundred watts. Due to the inconstancy of the operating regime, which is required by the necessity of ascertaining all the potentialities of this or that system, in the experiments the quantity of the nuclear fuel, the moderator, and the reflector is varied. Reconstruction of the active zone and selection of the critical mass are sometimes performed manually, with a concomitant danger of the development of a spontaneous chain reaction accompanied by considerable overirradiation of the personnel, since in distinction from a research reactor, the active zone lacks biological protection. Whereas with the observance of the rules of nuclear and radiation safety the annual radiation doses of the personnel are below the maximum permissible values, accidents can lead to an acute increase of the radiation doses. It has been shown that the probability of accidents due to a self-sufficient nuclear reaction is higher in critical assemblies than in the case of reactors. On the basis of generalization of the materials of observations of working conditions of personnel on critical assemblies, the publication "Sanitary Rules for the Designing and Operation of Critical Assemblies" (Moscow, 1972) has been developed, which covers a wide range of the aspects of radiation protection in work on such installations. (JPRS)

5424 PRODUCTION AND APPLICATION OF ULTRACOLD NEUTRONS. Steyerl, A. (Technische Univ. Muenchen, Garching (F. R. Germany). Physik-Department). pp 86-106 of Physics: Basis of Technology. Plenary Lectures. Weinheim, F. R. Germany; Physik Verl. (1974). (In German).

From 38th meeting of physicists'; Nuernberg, F. R. Germany (23 Sep 1974).

The present paper deals with the production of ultracold neutrons from reactor neutrons with the help of a beam tube and with a so called neutron turbine. As an example of application capture cross section measurements and studies of submicroscopic solid state structures and thin sheets are discussed. Finally storage possibilities of ultracold neutrons in so called neutron bottles are demonstrated. (GE)

5425 PRODUCTION OF A BEAM OF MONOENERGETIC POLARIZED NEUTRONS. Strothmann, H. (Physikalisch-Technische Bundesanstalt, Braunschweig (F. R. Germany). Forschungs-und Messreaktor). PTB Mitt.; 84: No. 5, 318-323 (Oct 1974). (In German).

At the research and measuring reactor of the Physikalisch-Technische Bundesanstalt experimental investigations are in preparation with the aim to measure the spin dependence of neutron cross sections by means of polarized neutrons and polarized nuclei. To this end a beam of monochromatic polarized neutrons has been produced by Bragg reflection in a Co–Fe single crystal. Using the shim method a degree of polarization from 0.74 to 1.0 has been determined in the neutron energy region from 10.5 eV to 0.029 eV. (auth)

5426 A FEASIBILITY STUDY ON POSSIBLE POWER RAISE OF WWR-C-RESEARCH REACTOR AT A. R. E. Fouad, H. Y. (Atomic Energy Authority, Cairo (Egypt)). Atomkernenergie; 24: No. 4, 279-282(1974).

A. R. E. has a WWR-C reactor, similar to Moscow University reactor, located at Inchas and operating at 2,000 kW thermal power. Its design features comprise 10% enriched uranium EK-10 fuel elements, light water moderator and coolant, aluminium cladding, and tank type core. A feasibility study on its possible power raise was aimed at building local reactor analysis capabilities and possible gains from flux raise reflected in shorter irradiation times and stronger experimental facilities. Alternatives for power raise comprised slight core lattice modification, increasing heat transfer capacity and a combination of both. Possible power raise estimates varied from 14% as a result of the first approach, 31.75 to 85% as a result of the second approach, and approximately 58 to 117% for the third approach. Complementary necessary activities are indicated. (auth)

5427 EXPERIMENTS FOR OBTAINING OF ULTRACOLD NEUTRONS BY THE METHOD OF MECHANICAL DELAY. Kashukeev, N.; Stanev, G. Sofia; Sofia Univ. (1974). vp. (In Bulgarian). INIS.

From 2nd national conference of the young physicists; Sofia, Bulgaria (10 Apr 1974).

Thesis.

The results of the experiments for obtaining ultracold neutrons carried out with MGUCN on the X horizontal channel of the IRT-2000 reactor in Sofia are presented. The dependence of the yield of ultracold neutrons on the velocity of rotation of the delaying rotor system of MGUCN was studied. The experimental and theoretically evaluated curves have the same course and coinciding maxima. A maximal yield of UCN was obtained at 828 rev/min. The maximal angle between the opening of the neutron channel for UCN and the working spade-mirror is determined to be 135°. A series of experiments with UCN passing through thin metal layers-filters was made for more precise establishing of the nature of the background and the effect. It was established that when covering the detector with a thin nickel layer (d = 0.5

μm) the effect completely vanishes, while the aluminium film (15 μm) decreases its value by half. The first fact is explained with the UCN velocities being smaller than the limiting velocity for nickel, since the reflecting surfaces of the MGUCN were nickeled. The second result is due to the fact that the UCN with a normal to the film velocity, smaller than the limiting one for aluminium, are reflected, while the rest part of the UCN spectra pass and are registered. The results proved the possibility for obtaining ultracold neutrons by delaying caused by successive reflections from a flat rotating neutron mirror in the MGUCN equipment. (INIS)

Production and Materials Testing and Processing Reactors

Refer also to abstracts 5347 and 5716.

Propulsion and Package Reactors

Refer also to abstracts 3292–3300, 3302, 3303, 3305, 3416, 3430, 3442, 3614, 3618, 3900, 3930–3935, 3964, 4001–4004, 4006, 4007, 4090–4092, 4122, 4123, 5616, 5618–5620, 5718–5726, 5728, and 5731.

5428 (AD-783962) SOVIET NAVAL OPERATIONS: TEN YEARS OF CHANGE. Weinland, R. G. (Center for Naval Analyses, Arlington, Va. (USA)). Aug 1974. 27p. NTIS $4.50.

5429 (AD/A-001561) NUCLEAR MERCHANT SHIPS. Final Report. (National Research Council, Washington, D. C. (USA). Maritime Transportation Research Board). Apr 1974. 136p. NTIS $5.75.

A strategy for developing U. S.-Flag nuclear-powered merchant ships is recommended. Key problem areas are identified and discussed, including comparative economics, safety and environmental quality considerations, and financial incentives and options. Four major conclusions and four principal recommendations are highlighted, and subsidiary conclusions and recommendations are also given. The main text is supported by 7 working papers included as appendixes: the future of U. S. foreign trade; costs and comparative costs for nuclear-powered and conventionally powered ships; the future price and availability of residual fuel oil; trade route alternatives for nuclear propulsion applications; health, safety, and environmental quality considerations; prospects of unconventional propulsion for merchant marine applications; and principal subsidies available to U. S.-Flag ships engaged in foreign trade. (GRA)

5430 (AD/A-002639) THERMIONIC CONVERSION. 25 Feb 1974. Translated from Komsomolskaya Pravda (USSR), N213, 1972. (FSTC-HT-23-1822-73). 6p. NTIS $3.25.

The role of thermionic reactors is discussed. "Topaz" type prototypes have been tested in the Soviet Union with quite satisfactory results. It is hoped that, in the next few years, they will be used in spacecraft and save millions of dollars in the space program. (GRA)

5431 (AGC-2200(Vol. 1)) NERVA ENGINE DEVELOPMENT PROGRAM AND ASSOCIATED TASKS. Final Report for the Period 10 July 1961—10 January 1962. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA)). Feb 1962. 92p. Dep. NTIS $7.75.

Declassified 11 Sep 1973.

This summary volume of the report submitted on completion of Phase I of the NERVA development program gives the overall design of the hot bleed engine as it existed at that time. It was decided that whole engine testing would be delayed until extensive research and development of critical components and subassemblies had been completed. This planned development program is discussed briefly, emphasizing reliability, quality control and safety. (LTN)

5432 (AI-AEC-12646) ADVANCED THERMOELECTRIC DEVELOPMENT PROGRAM. Progress Report, July–December 1967. Block, S. J.; Garvey, L. P. (Atomics International Div., Canoga Park, Calif. (USA)). 20 Feb 1968. Contract AT(04-3)-701. 130p. Dep. NTIS $9.50.

Declassified 7 Sep 1973.

The Advanced Thermoelectric Program is directed toward the development and testing of a direct-radiating thermoelectric module capable of operating for a period of five years at 1300°F with a liquid-metal-cooled nuclear system. Program activities are concentrated on testing and evaluation of the eight-couple silicon-germanium thermoelectric module using both electrical and NaK heating. The majority of the development of bonding systems and fabrication techniques as well as the fabrication of all modules have been completed. Testing of the modules is being performed at equivalent NaK temperature of 1300 to 1500°F. Although testing at 1400°F and higher has resulted in sporadic separations at the element hot-shoe bond in some of the modules, the anticipated minimum endurance life at the design NaK temperature of 1300°F remains at the five-year level. Module life tests at 1300, 1400, and 1500°F equivalent NaK temperatures have accumulated 11,564, 8,842, and 2,190 hours, respectively. Extrapolation techniques indicate that 2,190 hours at 1500°F is equivalent to > 5 years at 1300°F. (auth)

5433 (COO-2393-17) RESEARCH ON THE ANALYSIS OF NUCLEAR SPACECRAFT AND SPECIAL NUCLEAR REACTOR APPLICATIONS. Semiannual Progress Report, 1 July–31 December 1974. AMS Report No. 1215. Greenberg, J. S.; Layton, J. P. (Princeton Univ., N. J. (USA). Dept. of Aerospace and Mechanical Sciences). 15 Jan 1975. Contract AT(11-1)-2393. 40p. Dep. NTIS $5.00.

The analysis of nuclear spacecraft and special nuclear reactor applications is being conducted under the sponsorship of the Space Nuclear Systems Division of the AEC. The research deals primarily with two different, though related, aspects of nuclear power and propulsion systems. The first research area has been concerned with the economics of standardized and non-standardized nuclear powered spacecraft and power systems. The research has been directed at obtaining a clear understanding of the performance, reliability and economics of nuclear powered spacecraft and nuclear power systems for geocentric missions. The second research area has been concerned with the definition and analysis of aerospace and other special reactors under the cognizance of the Space Nuclear Systems Division of the AEC (i.e., such reactors as Uranium Zirconium Hydride (UZrH) thermal reactors and fast reactors with UO_2, UC, UN and other fuels as applicable in space and aeronautical flight regimes). Efforts have been made to define and analyze novel and advanced systems in sufficient conceptual detail so that fundamental feasibility and preliminary performance, reliability and economics may be assessed for various applications. (auth)

5434 (GA-8924) RESEARCH AND DEVELOPMENT ON FISSION-HEATED THERMIONIC CELLS FOR APPLICATION TO NUCLEAR SPACE POWER SYSTEMS. Summary Report for Period, October 1, 1967–June 30, 1968. (Gulf General Atomic Co., San Diego, Calif. (USA)). 2 Aug 1968. Contract AT(04-3)-167. 141p. Dep. NTIS $10.25.

Declassified 21 Mar 1975.

Progress is reported under the headings of materials technology, converter technology, converter testing, and reactor technology. (DG)

5435 (NAA-SR-9400(Vol.5)) LITHIUM HYDRIDE TECHNOLOGY: V. Testing and Examination of SNAP Shadow Shields. Welch, F. H. (Atomics International Div., Canoga Park, Calif. (USA)). 31 Aug 1967. Contract AT(04-3)-701. 94p. Dep. NTIS $7.75.

Declassified 5 Nov 1971.

The results of the X-ray examination, dimensional measurements, shock and vibration testing, and thermal cycle testing are described for each of twelve shields and test specimens. This work is a followup of the fabrication and casting program. The final destructive examinations which were made on seven of the twelve are described and an attempt is made to correlate the findings of the final examinations with observations made during the testing period. The special equipment and methods used to conduct the testing and examination program are also described. (auth)

5436 (NTO-R-79(Supp.1)) NRX/EST POST-TEST REPORT, Supplement I. (NERVA Test Operations, Jackass Flats, Nev. (USA)). [nd]. 40p. Dep. NTIS $5.00.

Declassified 30 Aug 1973.

Post-test metallographic examinations were made of NRX-A4-EST reactor fuel elements and of various metallic reactor components. (LTN)

5437 (NYO-3434-7) SUMMARY OF DESIGN, FABRICATION, PROTOTYPE TESTING, IN-PILE TESTING, AND HOT CELL EXAMINATION OF SD-4 THERMIONIC DIODE. June 1964–June 1968. Howard, R. C.; Dunlay, J. B.; Speidel, T. O. P.; Speidel, E. O.; Saling, J. H.; Storhok, V. W. (Thermo Electron Corp., Waltham, Mass. (USA); Battelle Columbus Labs., Ohio (USA)). 1968. Contract AT(30-1)-3434. 181p. Dep. NTIS $12.25.

Declassified 31 Aug 1973.

5438 (NYO-3873-1) 300-ekW THERMIONIC REACTOR DESIGN STUDY. Final Report. Schock, A.; Abbate, M. J.; Clarke, J.; Eisen, C. L.; Kamenetsky, H.; Rabb, B.; Vogel, E. (Fairchild

Hiller Corp., Farmingdale, N. Y. (USA). Republic Aviation Div.). 30 Sep 1968. Contract AT(30-1)-3873. 473p. Dep. NTIS $26.75.

Declassified 31 Aug 1973.

Design information for a 300 kw(e) thermionic reactor is presented concerning the thermionic converter, reactor core, reactor components and systems, nuclear characteristics, and power conversion system. (DCC)

5439 (ORNL-3571) SPACE POWER PROGRAM. Semiannual Progress Report for Period Ending December 31, 1963. Miller, A. J. (Oak Ridge National Lab., Tenn. (USA)). May 1964. Contract W-7405-eng-26. 276p. Dep. NTIS $17.00.

Declassified 31 Aug 1973.

Research and development on nuclear power plants for electrical power production in space vehicles is reported. The studies covered reactor design and development, heat transfer and fluid flow, materials research, and shielding. (JWR)

5440 (RN-S-0275) E/STS-2/3 NES DEVELOPMENT PLAN, PRELIMINARY. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1966. 39p. Dep. NTIS $5.00.

The development plan for the E/STS-2/3 Nuclear Exhaust System (NES) is described. The NES is designed to provide operational safety and full altitude simulation by use of a pumping, secondary ejector. Further, the capability exists for testing a 40 to 1 area ratio nozzle with 1.5° gimbal action. This duct configuration shall be capable of pulling in and allowing a 40 : 1 area ratio nozzle to be fully expanded at a nozzle chamber pressure of 550 psia without the use of the secondary ejector and at a nozzle pressure of 150 psia with the use of the secondary ejector using a low molecular weight pumping fluid. The ejector system shall have the capability of allowing nitrogen leakage from the engine compartment seals up to one pound per second as well as the turbine exhaust fluid to be exhausted into the engine compartment without affecting the ejector performance. (auth)

5441 (RP-MR-0019) PHOEBUS-2 MONTHLY PROGRESS REPORT FOR THE PERIOD 1 JUNE–30 JUNE 1967. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1967. 321p. Dep. NTIS $19.25.

The work reflected progress in design, fabrication, testing, repair, etc. of PHOEBUS-2 nozzles, pressure vessels and their interfaces. It also involved stress and thermal analyses and radiation heating calculations for these components. (LTN)

5442 (TID/SNA-691) RELIABILITY ALLOCATIONS, ASSESSMENTS, AND ANALYSIS REPORT. Volume I. Reliability Model, Predictions, and Allocations. Volume II. System Failure-Mode Effects and Criticality Analysis. Volume III. Trend Data. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1971. 498p. Dep. NTIS $28.00.

The preliminary reliability analysis results for the 75K NERVA Full Flow Engine are presented. Included are allocations and predictions, system failure modes and effects, single failure points, models, and trend data. The details of the reliability analyses for the non-nuclear subsystem are described. The analysis is based on Flight Engine Flow Diagram 1137401, Revision F. Brief summaries of the reliability analyses for the nuclear subsystem (NSS) are presented. (auth)

5443 (TID/SNA-1164) EVALUATION AND COMPARISON OF ALTITUDE CONTROL SYSTEMS FOR SPACECRAFT WITH NERVA ENGINES. (Aerojet-General Corp., Sacramento, Calif. (USA)). 9 Jul 1963. 11p. Dep. NTIS $4.00.

A comparison of the Aerojet configuration and the Lockheed configuration is presented according to simplicity, failure probability, system weight, and minimum overall vehicle length. (WHK)

5444 (TID/SNA-1229) ENVIRONMENTAL EVALUATION TESTING OF NERVA NRXA-2HF INSTRUMENTATION. (Aerojet-General Corp., Sacramento, Calif. (USA)). 2 Mar 1964. 27p. Dep. NTIS $4.50.

Candidate pressure transducers for NRX-A2 tests were tested at low and high temperatures (–300°F to +340°F and 77°F to 740°F). The units themselves withstood 765°F, but the cable failed. Difficulties were encountered in the initial low temperature tests due to the units having been previously pressure-tested with oil and residual traces froze at the low temperature. This oil was very difficult to remove and it is recommended that pressure transducers intended for low temperature service be tested only with dry nitrogen. (LTN)

5445 (TID/SNA-1424) LEAKAGE TEST OF NERVA ENGINE PRESSURE VESSEL METALLIC SEALS, SERIES NO. 2. Smith, L. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). 28 Apr 1964. 33p. Dep. NTIS $4.75.

Test 904N is being conducted in three series to evaluate various metallic seal designs being considered for use in the NERVA Pressure Vessel Assembly. The seals tested in Series II were designed by A.C.F. Industries. Test 904N, Series II, was performed to determine the amount of helium gas escaping past the seals at pressures up to 100% proof pressure. The maximum allowable leakage rate is 10^{-2} standard cubic centimeters/second per inch of seal diameter, which is 0.431 s.c.c./sec for the nozzle seal and 0.510 s.c.c./sec for the forward closure seal. Three seal sets of this design were tested with three pressure cycles per set. The maximum leakage rate for each nozzle seal was 0.330, 1.585, and 0.137 s.c.c./sec. Maximum leakage for all three seals occurred at 100% proof pressure. The maximum leakage rate for each forward closure seal was 4.45, 4.56, and >500 s.c.c./sec. Maximum leakage occurred at about 40% proof pressure for all three seals, decreasing with increased pressure. (auth)

5446 (TID/SNA-1425) NRX-A PRESSURE VESSEL METALLIC SEALS, TEST SERIES I EVALUATION REPORT. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 Jan 1964. 79p. Dep. NTIS $7.00.

Series I NERVA pressure vessel metallic seals test, also known as Test 904N, Series I, was conducted during August and September 1963. The test successfully demonstrated the integrity of pressure vessel closure S/N 002, which had undergone repairs at the vendor's facility. The test evaluated three sets of one seal configuration designed to limit helium gas leakage to less than 10^{-2} standard cubic centimeters per second, per inch of diameter, at proof pressure of 645 psig. The quantity of leakage measured differed considerably from set to set because of variations in test conditions, seal groove cleanliness and seal to seal variation. The design requirement for leakage to be less than 10^{-2} standard cubic centimeters per second per inch of diameter should be reevaluated. (auth)

5447 (TID/SNA-1450) MECHANICAL IRRADIATION TEST 3/L001 TURBOPUMP BEARING SET. Volume I. Final Test Report No. 1.9.5-1E. Warner, M. H. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1964. 82p. Dep. NTIS $7.25.

Candidate turbopump bearings mounted on NERVA Bearing Tester P/N 263520-39, S/N 0000002 were tested at the General Dynamics, Fort Worth, Texas, reactor facility on 17 July 1963. This test (mechanical Irradiation Test No. 901) was conducted at the Aerospace Test Reactor (ASTR). Reactor power level was maintained at 10 megawatts for the entire test duration of 327 seconds. Bearing operation with low thrust loads at 23,000 rpm was terminated after 155 seconds when a pre-established bearing temperature kill limit of –150°F was reached. The bearing temperature increase, experienced during the test, is attributed to a combination of nuclear heating and an inadequate mass flow of hydrogen, not to bearing malfunction. The inadequate mass flow of hydrogen was a result of the large system pressure drop and the facility-limited hydrogen supply pressure. Operation of the bearings was normal and the test was considered satisfactory. The tester was disassembled. All components showed only the normal signs of operation and were in good condition. Both roller bearings and thrust bearings were in good condition. The roller cages showed evidence of very slight pocket burning and a slight discoloration on the pump-end bearing inner race. (auth)

5448 (TID/SNA-1540) ON SITE RADIOLOGICAL REPORT FOR THE PHOEBUS IB REACTOR TEST SERIES. (Pan American World Airways, Inc., Las Vegas, Nev.). 18 Aug 1967. 54p. Dep. NTIS $5.75.

Radiological support for the Phoebus IB reactor test series was conducted essentially according to pre-test plans. The radiation levels at the Control Point during powered operations were a factor of 16 less than on previous full powered runs, resulting from the use of the reactor shield. Although the hot line for EP-IV was along the five degrees azimuth from the Cell, changing wind conditions attendant with pulse cooling produced on-site contamination at all populated facilities except E-MAD and ETS-1. The maximum particle concentration at any facility was 120 particles per 100 square feet at R-MAD. Five per cent of 4,100 contamination checks indicated contamination on personnel or their clothing up to an uncorrected radiation level of 200 mR/hr beta-gamma. Decontamination to within the guides, which were increased on run night and the next day, was successful for all skin contamination incidents and for most clothing contamination cases. A discrete particle was detected on each of two individuals. The total radiation exposure received at Test Cell "C" was 112.5 R during the period from EP-I until the end of March. The maximum individual cumulative exposure was 2.02 R. The major Test Cell decontamination efforts accounted for 80 R of exposure, took about one month, and required the expenditure of $98,100, which included 5,550 manhours. Positive activities of non-natural-occurring radioisotopes were detected in 19 individuals out of the 61 who were subjected to whole body counting. As many as five isotopes were detected internally in one individual. The maximum

body burden fraction in a single organ was 0.123 for the thyroid. However, the residence time appeared to be three days or less for all internal depositions. (auth)

5449 (TID/SNA-1697) FIRST MONTH'S LETTER PROGRESS REPORT. Reusable Nuclear Stage System Definition Study. Phase IV. Report Period, September 13–November 30, 1971. Schweickert, W. E. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif. (USA)). 15 Dec 1971. 27p. Dep. NTIS $4.50.

For Aerojet-General Corp.

Various space shuttle concepts have been defined and preliminary design optimization and logistic analyses initiated. The engine/stage interface review identified a number of areas where either a NERVA modification is recommended or further analysis is required. Facility modification to ETS-1 required to test the propulsion module have been defined. (LTN)

5450 (TID/SNA-1698) SECOND MONTHLY LETTER PROGRESS AND STATUS REPORT. Reusable Nuclear Stage System Definition Study. Phase IV. Report Period, December 1–December 31, 1971. Schweickert, W. E. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif. (USA)). 12 Jan 1972. 19p. Dep. NTIS $4.00.

For Aerojet-General Corp.

Various shuttle vehicle and propellant module concepts were studied. An interface review meeting was held and the recommendation presented will be reviewed. Four active trade studies are discussed. Launch systems and logistics are being examined. (LTN)

5451 (TID/SNA-1720) NOZZLE ASSEMBLY DESIGN STATUS REVIEW. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1971. 287p. Dep. NTIS $17.50.

Material presented at a design review meeting on the NERVA nozzle assembly has been documented. Several aspects of nozzle design are treated: materials, cooling methods, reliability, fabrication methods development, testing, remaining problems, etc. (LTN)

5452 (TID/SNA-1724) FLOW CHART: STRUCTURAL ANALYSIS OF NERVA SKIRT AND EXTENSION (PRELIMINARY). de la Garza, W. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1967. 207p. Dep. NTIS $13.50.

Work on the stress analysis of proposed nozzle skirt and extension designs has been documented. Thermal and mechanical stresses are considered in view of the problems of nuclear heating, cooling, material selection, etc. (LTN)

5453 (TID/SNA-1725) SELECTION OF BRAZING PROCESS FOR NERVA-ENGINE SKIRT-DEVELOPMENT PROGRAM. Spaletta, H. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Apr 1970. 50p. Dep. NTIS $5.50.

The development of furnace brazing procedures for proposed NERVA AISI 347 skirts is described. Braze alloy selection was based on the results of metallographic examination, fabrication of specimens, and review of current literature. The test program using vertical flow specimens, brazed Titan tube specimens, and fabrication of a simulated full scale skirt assembly indicates that an acceptable skirt can be assembled using Palniro-7 (70 Au–8 Pd–22 Ni) for the first braze cycle and Nioro (82 Au–18 Ni) for the second cycle. (auth)

5454 (TID/SNA-1729) THRUST BUILDUP STATE VARIABLE FEEDBACK CONTROL SYSTEM FOR THE E-1 CAM. Revision 6.1. Parziale, E. A.; Schenz, R. F. Jr. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 1 Jul 1971. 108p. Dep. NTIS $8.50.

Material for the E-1 Common Analog Model (CAM), revision 6.1, is documented. There are three major sections. The first presents design results for the state variable feedback control system and gives references for the techniques employed. Next, the digital program implementing the control system equations is discussed. Finally, E-1 CAM hybrid simulation responses are given for nominal thrust buildup and thrust buildups under various other conditions for comparison with performance requirements and system constraints. Included are thrust buildups demonstrating single TPA operation, end of life performance, sensitivity to open loop demands, impact of single feedback failure, and selected malfunction responses without corrective action. (auth)

5455 (TID/SNA-1732) SYSTEM ELECTROMAGNETIC COMPATIBILITY PLAN (PRELIMINARY). Goulden, D. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 30 Apr 1971. 46p. Dep. NTIS $5.50.

It is recommended that efforts to ensure electromagnetic compatibility be incorporated into the early design of the NERVA engine and continued throughout. Attention should be given to filtering, shielding, grounding, etc. to minimize interference and effects of transients, corona and lightning. Care should be taken to avoid direct contact between dissimilar metals that would result in galvanic action or corrosion. Also bonds should be reliable. A formal management effort to plan, control and implement electromagnetic compatibility throughout the design, procurement, production and test phases of the NERVA program is recommended. (LTN)

5456 (TID/SNA-1733) ENGINEERING OPERATIONS REPORT: MULTIPLEXER CIRCUIT DEVELOPMENT. Jennings, R. F. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). May 1972. 18p. Dep. NTIS $4.00.

The objective of the multiplexer circuit development program was to develop a multiplexer design to meet the NERVA rocket engine flight instrumentation requirements when operating exposed to the radiation and temperature extremes present at its location on the engine. The development plan included design trade studies, breadboard design and fabrication, evaluation test phase, establishment of a multiplexer design specification, and completion of a preliminary design. To aid in conducting the trade studies, breadboard design, and circuit evaluation tests, a development test unit was designed. This unit consisted of a multiplexer front-end, sample and hold, analog-to-digital converter, display unit, and associated control logic. Due to cancellation of the program, none of the proposed development plan was initiated. The development test unit was fifty percent completed. (auth)

5457 (TID/SNA-1735) IRRADIATION TEST FOR CANDIDATE NERVA PIEZOELECTRIC ACCELEROMETERS, GROUND TEST REACTOR IRRADIATION TEST NO. 23. Jang, S. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Mar 1972. 20p. Dep. NTIS $4.00.

The primary purpose of the proposed experiment is to determine quantitatively the permanent effects of high neutron fluence on the performance characteristics of the candidate piezoelectric ceramic elements. The test is to be conducted with the test items subjected to the highest possible neutron fluence in the reactor. The test, designated as GTR-23, is an irradiation test program of candidate piezoelectric ceramic accelerometer elements to be considered for use in the design of NERVA accelerometers to monitor engine vibration levels. The specific test objective is to evaluate the effects of a fast neutron fluence environment on the performance characteristic of candidate piezoelectric ceramic accelerometer elements with respect to radiation-induced changes in frequency response, charge sensitivity, capacitance, and insulation resistance. The primary candidate piezoelectric ceramic elements are three high temperature materials that have Curie temperature in excess of 1400°R. These are the Gulton G 9100 ceramic and the Endevco P-14 and P-15 ceramics. (auth)

5458 (TID/SNA-1736) EVALUATION OF IRRADIATION TEST RESULTS FOR CANDIDATE NERVA PIEZOELECTRIC ACCELEROMETERS GROUND TEST REACTOR IRRADIATION TEST NO. 22. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Dec 1971. 83p. Dep. NTIS $7.25.

Sixteen accelerometers and four temperature compensating capacitor assemblies were irradiated in the GTR-22 test to determine the effects of nuclear radiation on the performance characteristics of the test items. The test was passive with no vibration stimulus during the irradiation period. Analysis was accomplished by comparison of pre- and post-test calibration data and correlation of observed changes in characteristics with fast neutron exposure. All test items used in the experiment were provided by the manufacturers, Gulton and Endevco, for the purpose of evaluating three new high temperature piezoelectric ceramic materials that have Curie temperatures greater than 1400°R. The test items were irradiated at four neutron fluence levels ranging from 7.96×10^{16} to 2.71×10^{18} n/cm^2 (E > 1.0 MeV) with one accelerometer from each group irradiated at each level. The data obtained were of sufficient quality to enable the resolution and correlation of radiation effects for various transducer performance characteristics. Analysis of the data indicated that the lead zirconate-titanate piezoceramic material deteriorated as expected with the output decreasing to approximately 40% of pretest at a fluence of 2.51×10^{18} n/cm^2 (E > 1.0 MeV). In comparison, no discernable radiation effects were observed in the outputs of the three high temperature accelerometers. Post-test calibrations were within ±3% of pretest for the Gulton AQB 4981A and Endevco 2273-M9 groups of accelerometers, which is within the uncertainty level of the vibration calibration system. The post-test calibrations for the Endevco 2285-M3 group were within ±10% of pretest. The larger uncertainty is attributed to calibration system resolution limitations since the charge sensitivity of this group was quite low at 2.00 pico-coulombs/g. The most significant radiation effect observed was the decrease in capacitance with neutron fluence in

three of the four groups of accelerometers. A correlation appears to exist between the magnitude of the capacitance decrease with increasing neutron fluence and the Curie temperature of the piezoceramic material. (auth)

5459 (TID/SNA-1738) NOZZLE ASSEMBLY TRADE STUDY. Shurley, L. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). May 1970. 110p. Dep. NTIS $8.50.

Four major aspects defining the nozzle assembly, each constituting a sub-trade study in itself are examined. Major aspects are those which, as a part of the overall configuration, have a direct relationship to engine operation, performance, and ability to meet requirements. These sub-trade studies are: determination of the nozzle-assembly terminal area ratio; determination of location of nozzle-extension attachment point; determination of location of the coolant inlet torus; and selection of one-piece primary nozzle or two-piece (nozzle and skirt) cryogenically-cooled subassembly. In addition to the above configuration-oriented major items subject to optimization, certain ancillary design parameters were considered. Such parameters do not affect the engine operation directly but do influence the nozzle functional characteristics, primarily with respect to reliability. (auth)

5460 (TID/SNA-1739) NERVA SOFTWARE AND COMPUTER EVALUATION STUDY. (Computer Sciences Corp., Las Vegas, Nev. (USA)). 1 Feb 1971. 174p. Dep. NTIS $11.75.

For Aerojet Nuclear Systems Co., Sacramento, CA.

The results of two closely related studies performed by Computer Sciences Corporation (CSC) for Aerojet Nuclear Systems are reported. The Software Evaluation Study was primarily oriented toward assisting Aerojet in determining the software requirements for the NERVA engine control development and test program. The Computer Evaluation Study was designed to assist Aerojet in selecting a computer family for control software development and engine control in ground tests. The methods are described and the conclusions reached in 1971 given. (auth)

5461 (TID/SNA-1749) NERVA NOZZLE BOLT COOLANT SYSTEM DESIGN STUDY REPORT. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Jul 1970. 58p. Dep. NTIS $6.00.

This design study report covers the approaches undertaken for selection of a design concept for the NERVA nozzle bolt coolant system for the full-flow cycle engine. After selection of the required number of nozzle flange bolts, the two design approaches that were proposed (an internal and an external feed concept) were compared on the basis of their failure modes and mechanisms and resultant failure rate potential. As a result of this analysis, 108 bolts were selected; and the internal feed concept was established as the desired design for the bolt coolant system on the basis of anticipated higher reliability because of fewer potential leak paths and a redundant bolt cooling feature. Further design study was then conducted on the internal feed concept; a fluid analysis was conducted at nominal and off-design conditions of 60% malfunction throttle mode, three transient modes (70, 45, and 25% power levels), and feed hole tolerance condition. On the basis of this analysis, sufficient flow rate was obtained to provide adequate cooling in each case. A stress analysis was also conducted on the internal feed concept. Because of higher applied structural loads with the full-flow cycle engine, the proposed concept was not acceptable. Alternative flange design concepts to withstand the higher applied structural loads are under investigation. These new concepts will retain the basic internal feed system approach of obtaining coolant but may require the addition of external cooling of the jacket. (auth)

5462 (TID/SNA-1761) ENGINEERING OPERATIONS REPORT: SHUTDOWN CONTROLS FUNCTIONAL DESIGN. Schenz, R. F. Jr. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 27 Sep 1971. 34p. Dep. NTIS $4.75.

The analysis describes a state variable shutdown controller for use on the hybrid CAM with the NERVA E-1 (Revision 6.1) model. The objective was to provide a satisfactory controller by modifying the thrust buildup (TBU) controller. The limitations were that the effort and modifications to the TBU controller were to be kept to a minimum. The controller was to permit shutdown of the CAM without exceeding any of the engine constraints, but was not to be optimized. A shutdown controller has been designed that will bring the E-1 CAM engine model from the design power down to a power level of 45 Mw which is the lower limit of the CAM. Shutdown runs were made at start of life and end of life with both 5 and 20 minutes of decay heat without exceeding any of the engine constraints. Use of the TBU controller in reverse with minor modifications provides a satisfactory state variable shutdown controller. The results also show that with a state variable controller, a special pump tailoff controller is not necessary. The analysis covered nominal shutdowns only, starting with two pumps and switching to single TPA operation at a low level. Future work should include investigation of shutdowns from the single TPA operating point and the emergency operating point. Sensitivity as well as malfunction studies should also be conducted. (auth)

5463 (TID/SNA-1763) NERVA EXTERNAL SHIELD. Breindel, B. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1971. 72p. Dep. NTIS $6.75.

The conceptual design of the NERVA External Shield, Layout Drawing No. 1138352 is documented. The intent is to summarize work performed on the External Shield design during the time period from October 1968 through its March 1971 maturity and form a basis for future external shield design efforts. Shield design and analysis activities were terminated in March 1971; hence, this is an interim component design report. The External Shield Requirements, Mechanical Design, Performance, Nuclear Radiation Analysis, Thermal Analysis, Structural Analysis and Reliability and Safety Analysis for the current design maturity are presented. A complete set of references for the External Shield design and analysis is included to serve future design activity. (auth)

5464 (TID/SNA-1771) STRUCTURAL RELIABILITY ANALYSIS TECHNIQUES AND REFLECTOR EXAMPLE. DeSalvo, G. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 7 Oct 1968. 50p. Dep. NTIS $5.50.

Work done by the Structural Analysis group in applying the methods developed by WANL and SNPO for Structural Reliability Analysis is described. The report gives a brief explanation of the statistics involved in reliability calculations and a derivation of the basic overlap or load-strength interference method. The material is presented in a way that agrees with the nomenclature and examples of SNPO-C-1, Draft No. 2. Design type curves have been worked out such that quick estimates can be made of the reliability, assuming theoretical gaussian distributions of an infinite sample size. These are useful for first estimates of the reliability by designers. Methods of calculation are also shown for finite sample size as per the method suggested both by W. Horton and SNPO-C-1. The reliability theory is applied to the outer web of the A6 reflector to find the probabilities of failure associated with the calculated and experimentally obtained loads. Also, for a given reliability goal, the mean loads and load deviations that can be tolerated for new designs are obtained. Two theories of failure are considered and compared in determining the reflector outer web structural reliability. One is based on the ultimate tensile strength and the other on a fracture toughness approach. (auth)

5465 (TID/SNA-1803) NUCLEAR ROCKET UNCOOLED NOZZLE STUDY PROGRAM. Phase III. (Aerojet-General Corp., Sacramento, Calif. (USA)). 31 Mar 1972. 132p. Dep. NTIS $9.75.

The primary objective of the third phase of the Nuclear Rocket Uncooled Nozzle Study Program was to complete the design of a fibrous graphite (AGCarb 101) nozzle which could be shown to be a feasible substitute for the present NERVA regeneratively-cooled nozzle design. The nozzle design, attachment techniques, materials of construction, and fabrication processes considered were aimed at producing a fail-safe nozzle design having improved engine performance over the regeneratively-cooled nozzle design. The structural and thermal analyses conducted during this program resulted in a final design for an uncooled nozzle assembly which satisfied program requirements, and had stress levels within the AGCarb 101 material limits. The computer decks and output data preserved represent the analyses of all configurations explored during Phase III of Project 398F. The preliminary fabrication specification is basically completed, except that several of the material designations and secondary process specifications are not yet determined. Probably the most important element not defined on this specification is the designation and processing requirements for the metal carbide corrosion barrier. With these qualifications the assembly layout and detail fabrication drawings represent the final configuration for the uncooled nuclear rocket nozzle and associated components. (auth)

5466 (TID/SNA-1806) STATE POINTS FOR THE 1137400/REVISION E REFERENCE ENGINE. Stephens, W. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 26 Feb 1971. 56p. Dep. NTIS $6.00.

The state point conditions and specification extremes to be used in developing engine and component specifications for the Reference Engine 1137400/Revision E as defined in N4110: 2049 are provided. Heat transfer and thermal analysis of nozzle coolant channels are included for some of these specified state points; pressure drop data are given for a few conditions. (LTN)

5467 (TID/SNA-1808) TECHNICAL AND USERS MANUAL FOR PROGRAM E25107 NOZZLE HEAT TRANSFER. Williams, J. J. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Feb 1972. 149p. Dep. NTIS $10.50.

The formulae, which are the basis of the computer code, E25107, used to calculate the thermal performance of regeneratively-cooled rocket nozzles, are described. The results obtained with this program in correlating NRX-A5 and NRX-A6 test data are plotted. (LTN)

5468 (TID/SNA-1809) NOZZLE PERFORMANCE LOSS ANALYSIS, CONTOUR IMPERFECTION (W.O. 1190-14-109). Williams, J. J. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 7 Jun 1971. 83p. Dep. NTIS $7.25.

The performance loss of NERVA nozzles has been calculated for flaws, erosion, vibrations, etc.: circumferential discontinuity 0.50 inch deep at an area ratio of 24 : 1; contour imperfections resulting from flow anomalies which cause shocks sufficient to influence nozzle wall pressure distribution; errors in tables used; contour imperfections resulting from graphite erosion; vibrations; contour variations; poor mixing; divergence; boundary layer loss; etc. The erosion and/or corrosion of graphite by hydrogen is estimated for different temperature and pressure conditions based on different assumed likely kinetic behaviors. (LTN)

5469 (TID/SNA-1811) ENGINEERING OPERATIONS REPORT: STEADY STATE TEMPERATURES FOR THE NERVA NOZZLE/PRESSURE VESSEL AND REFLECTOR JOINT NUMBER 1138000-D USING SPECIFICATION EXTREME VALUES FOR NUCLEAR HEATING RATES. Williams, J. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Feb 1972. 197p. Dep. NTIS $13.00.

Thermal analyses of the NERVA nozzle/pressure vessel and reflector joint were made under conditions of normal and extreme values of nuclear heating rates. Extreme temperatures (700–800°F) calculated for early designs were reduced appreciably by design changes to increase heat transfer. (LTN)

5470 (TID/SNA-1815) SNP-1SA3 CONTRACT MONTHLY LETTER REPORT FOR THE PERIOD 27 MAY 1963–26 JUNE 1963. Peterson, J. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 8 Jul 1963. 118p. Dep. NTIS $9.00.

Progress is reported mainly related to the design, fabrication and testing of nozzles, pressure vessels, and turbopumps. The Cold Flow Development Test System and the NRX-A1 Engine were being designed and constructed. (LTN)

5471 (TID/SNA-1820) XE-2 NOZZLE ASSEMBLY READINESS REPORT. Claassen, L. B. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 11 Jul 1968. 70p. Dep. NTIS $6.75.

A documentary proof that the P/N 1114263-99 nozzle is suitable for inclusion in the XE-2 engine assembly and is satisfactory for XE-2 power test within the limits and constraints specified is provided. Pertinent excerpts from records and documentation related to aspects of XE-2 nozzle operation with emphasis on items unique to this P/N, and residual deviation from applicable documents with engineering disposition thereof are included to render this report a self-contained document. The nozzle and hot gas bleed port assembly which is intended for use on the XE-2 assembly is P/N 1114263-99, S/N 880028. It was designed and fabricated under Contract SNP-1. Design differences in the XE-1 and XE-2 nozzles exist only in that the XE-2 nozzle was at one time built to NRX/EST configuration and instrumentation requirements. It has since been modified as necessary so that no configuration or operational differences exist. (auth)

5472 (TID/SNA-1838) ANSC PROGRAM POSITION REGARDING COMPONENT DESIGN VS MATERIALS PLAN PRIORITIES. Campbell, W. E.; Ramsthaler, J. H. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 11 Feb 1971. 38p. Dep. NTIS $5.00.

Slides presented at a review meeting on component design and materials properties have been documented. The management approach to selecting materials to meet design requirements (or sometimes altering design) is developed on the basis of failure mode analysis, materials testing, statistical methods of interpretation and acceptance testing, etc. with specific applications to certain turbopump components. (LTN)

5473 (TID/SNA-1865) ADAPTER TEST SUMMARY FILE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1965. 8p. Dep. NTIS $4.00.

Tabular test results are presented. Items are identified by number and some brief comments are included. Test conditions are given. (LTN)

5474 (TID/SNA-1866) PATTERN TEST SUMMARY FILE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 49p. Dep. NTIS $5.50.

Tabular results on NERVA nozzle tests have been documented. Nozzles are identified only by letter code and numbers. (LTN)

5475 (TID/SNA-1878) HARDWARE TEST SUMMARY FILE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 16p. Dep. NTIS $4.00.

Tabular test results on nozzles identified by number are given. The testing conditions are defined and very brief comments on the results are listed. (LTN)

5476 (TID/SNA-1892) NUCLEAR SHUTTLE SYSTEM DEFINITION STUDY. Phase II. First Interim Review. Littman, T. M. (North American Rockwell Corp., Downey, Calif. (USA). Space Div.). 2 Sep 1970. 183p. Dep. NTIS $12.25.

It can be concluded from the data presented that a single cell configuration with cone angles between 7 to 8° with an end cap 25 inches in radius offers the maximum performance for a radiation dose of 10 Rems at tank top. As the radiation dose criterion is changed to 25 Rems, the maximum performance point shifts to half cone angles in the area of 8.5 to 9° maintaining the 25 inch cap radius. A further relaxation on the radiation dose to 50 Rem shifts the maximum performance point again to approximately 15° half cone angle still maintaining the 25-inch cap radius. The resulting stage length less nose cone varies from 190 feet for the 10 Rem criteria to a 165 feet for the 50 Rem. The respective tank lengths vary from 165 to 127 feet demanding in all cases separate launches for the tank and the NERVA to minimize launch vehicle modifications. It is of importance to note that the loads data presented are for a minimum load trajectory where the angle of attack is limited to a maximum of three degrees during the high dynamic loads region. The engine disposal operation also presents design considerations that could affect the overall system structural arrangement selection. The considerations listed above favor the selection of a single cell configuration with a conical aft bulkhead (ϕ = 8.5 degrees, R = 25 inches) as an alternate baseline. This configuration appears to offer added flexibility over the hybrid design with a separate propulsive module. It is further recommended that a joint Aerojet/NR engine/tank docking system design effort be initiated satisfying the engine design criteria as well as the system operational requirements associated with orbital mating and demating of engine/propellant tanks. (auth)

5477 (TID/SNA-1918) TURBOPUMP ASSEMBLY PROCEDURE. Pare, P.; Petersen, T. (Aerojet-General Corp., Sacramento, Calif. (USA)). 20 Mar 1972. 205p. Dep. NTIS $13.25.

The procedure required for the assembly of the NERVA Turbopump is presented. The procedure is step by step; with appropriate steps requiring sign off by Project and Quality Engineering. The document is complete unto itself, although the reference (within the procedure) drawings are required to support the assembly. The information provided will, if carried out, result in a complete turbopump assembly. The adequacy of the procedure cannot be determined until it is implemented; i.e., a turbopump is actually assembled. (auth)

5478 (TID/SNA-1960) PRELIMINARY TURBOPUMP TEST FACILITY REQUIREMENTS. Andrews, F. X. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 7 Mar 1971. 25p. Dep. NTIS $4.25.

Test facility requirements for NERVA turbopump testing at the test cell "C" facilities of NRDS are established. It is assumed that pump assembly, testing and disassembly will be supported at NRDS. Liquid hydrogen supplies, control equipment and hydrogen disposal facilities are described and shown schematically. The operating conditions and information required are specified (suction performance, effects of two-phase flow, performance at certain specified conditions, etc.) The pump control equipment, measuring instrumentation, data acquisition systems and planned data processing are described briefly. (LTN)

5479 (TID/SNA-1972) ENGINEERING METHODS; KINETIC, DIVERGENCE AND BOUNDARY LAYER PERFORMANCE LOSS CHARTS. Pieper, J. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 27 Nov 1968. 90p. Dep. NTIS $7.50.

Design charts for predicting performance losses resulting from kinetic, divergence, and boundary layer effects are provided. The kinetic performance loss accounts for the effect of finite reaction rates which do not permit equilibrium compositions to be maintained during the combustion gas expansion process. The divergence performance loss accounts for the two-dimensional inviscid flow effects which occur within the nozzle. These effects include: Nonplanar sonic surface which influences both the mass flowrate and thrust and nonaxially directed gas flow at the nozzle exit which

influences the resultant axial momentum (thrust). The boundary layer performance loss results from viscous and heat transfer effects which influence the local velocity and density of the expansion gas mixture, and are generally confined to a thin layer along the thrust chamber wall. As a result of these effects, the total momentum and mass flux of the system are altered from their respective inviscid adiabatic flow values, affecting both the performance and effective nozzle cross sectional area. The performance loss charts are intended for use with preliminary design and proposal efforts and cost or time limited analyses. They are also suitable for parametric analyses for design optimization. Under other conditions, where best available accuracy is desired, specific performance loss calculations should be made. (auth)

5480 (TID/SNA-1975) ENGINEERING OPERATIONS REPORT: BURST TESTING OF THE NERVA TURBOPUMP TURBINE ROTOR ASSEMBLY. Harris, C. L. (Aerojet Nuclear Systems Co , Sacramento, Calif. (USA)). Apr 1972. 35p. Dep. NTIS $4.75.

The exact solution of the structural integrity of complex turbomachinery rotor configurations is difficult to achieve due to the great complexity of the elastic and plastic analysis that would have to be performed. The accepted practice of determining the safety margin of complex configuration rotor discs is to compare the disc operating speed to the speed at which burst occurs. An empirical formula has been developed to calculate disc burst speed based on a purely elastic analysis of the stresses in the disc, but because the method is empirical, it is customary practice to spin test a fully machined rotor to determine the actual burst speed. Fully machined first and second stage turbine rotors (P/N 1139459-1) fabricated from Titanium 5A1-2.5 Sn ELI forged material were assembled and subjected to spin testing. Examination of the turbine rotors following a non-destructive test to 33000 rpm showed no evidence of cracking or permanent deformation. Subsequent attempts were made to achieve rotor burst but were halted when gross plastic deformation of the rotor set resulted in a severe out-of-balance condition that prohibited further increases in speed. The predicted burst speed of 42100 rpm was exceeded on each attempt to achieve burst, indicating a conservative analysis. Although there was evidence of significant yielding, no indications of cracking were found after dye penetrant inspection of both rotors. (auth)

5481 (TID/SNA-1981) NERVA NOZZLE COOLANT CHANNEL THERMAL EVALUATION WITH FLOW SEPARATION. Brown, R. L. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 5 Oct 1970. 3p. Dep. NTIS $4.00.

Nozzle coolant channel gas side wall temperature, coolant pressure drop and bulk temperature increase were calculated for nozzle separation ratios of 12 and 14. The prevailing run conditions used were as defined by the state point data of 19 May 1970 for engine configuration 1137400S. Run 215A, representing the full power, end of life, flight condition, is included for comparison purposes. (auth)

5482 (TID/SNA-1987) STATISTICAL DISCUSSION OF RISKS INCURRED IN ACCEPTANCE AND HYPOTHESIS TESTING. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 7 Jun 1971. 13p. Dep. NTIS $4.00.

Producer's and consumer's risks in acceptance testing are explained with examples. The importance of confidence level and the number of samples of each lot tested on each type of risk is developed. Then the problems in hypothesis testing (i.e., whether, on the basis of sample tests, the population mean has changed) are considered, again with examples. Then, this information is used to discuss the responsibility of testing enough samples to assure that type II errors are controlled in meeting the reliability specification. The Reliability Specification is "The basis of this assessment shall be statistical tests of hypotheses comparing, at the 10% level of significance, values determined or predicted during the analytical-design process with observed values." The problem of whether the actual observed stresses on a part are the same as those used in the analytical-design step is also considered briefly in this same connection. (LTN)

5483 (TID/SNA-1990) COMMENTS ON INTREMOLD III CYLINDER TEST SPECIMEN CUT-OUT DRAWINGS AND TEST MATRIX. Jellison, J. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 14 Oct 1971. 17p. Dep. NTIS $4.00.

Problems in testing the NERVA nozzle extension are discussed. The problems concern the determination of the needed mechanical properties of this composite material. Joints of the materials involved are covered with glass wrap which is impregnated with the bonding material which bonds it to the aluminum and graphite. The mechanical properties of these joints are important. The problems discussed relate mainly to the definition of the specimens and the nature of the tests to be performed on them. Thermal and stress analyses were made on flange concepts and failure theory of graphite composites was considered. Otherwise, results were not attained when the contract was closed. (LTN)

5484 (TID/SNA-1991) NOZZLE EXTENSION NONDESTRUCTIVE TEST PLAN. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 29 Dec 1971. 17p. Dep. NTIS $4.00.

Nondestructive testing methods for quality assurance tests of fibrous reinforced graphite composite material are assessed, in reference initially to the testing six Intremold III cylinders. The methods considered are: Alcohol penetrant, x-radiography, neutron radiography, eddy current, ultrasonic and thermal. The aim is to identify flaws and their effects, so an inspection procedure can be developed. It is considered that one or more of the above methods will be adequate, perhaps after some development, but certain other methods will be sought by means of literature surveys and some experimental investigations. (LTN)

5485 (TID/SNA-2020) ENGINEERING OPERATIONS REPORT: PROBABILISTIC DESIGN TRAINING COURSE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 2 Jun 1972. 275p. Dep. NTIS $16.75.

One of the technical accomplishments of the NERVA development program was the use of the probabilistic design approach. A broad collection of probabilistic design methods, techniques, and procedures were developed. In order to implement these methods into the design process, however, it was necessary to develop training courses for the engineers involved in the design/development of the NERVA engine. A number of these courses were presented to the engineering and program management personnel to familiarize them with the basic concepts of the probabilistic design approach. Using one of the courses presented as a basis, a revised training course in probabilistic design has been developed and is presented in Appendix A. The course reflects the knowledge and experience accumulated in the actual implementation of the probabilistic design approach, and as such, it can be of valuable service to any other organization contemplating the use of this approach. The training course consists of eight lectures plus four sessions devoted to class solution of problems in the probabilistic design approach. (auth)

5486 (TID/SNA-2022) ENGINEERING OPERATIONS REPORT: THERMAL ANALYSIS OF THE CLOSURE JOINT OF THE 1138808B NERVA PRESSURE VESSEL. Thompson, W. R. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 31 Aug 1971. 49p. Dep. NTIS $5.50.

Design changes in the closure joint of the NERVA pressure vessel have resulted in a requirement to re-analyze this region to determine its thermal characteristics. The modifications include both geometry and material changes as well as differences in state point data, etc. Simplified parametric analysis of the closure joint for the 1138808B pressure vessel, together with the results of earlier more detailed calculations, give steady state temperature distributions. Primary interest is for the fullpower flight engine at the Normal Design Point for End-of-Life with thermal parameters at specification extreme. The most representative calculation indicates the A286 closure bolt to be almost isothermal, varying axially from −99 to −116°F (361 to 344°R). The aluminum alloy 7075 pressure vessel flange varies from −150 to −157°F (310 to 303°R) while the closure flange ranges from −139 to −142°F (321 to 318°R). Other calculations showed the effect of doubling of the heating rates, insulating the bolt head, and changes in bolt-to-flange conductance. Three runs were made for nominal NETAP state point data (all other parameters remain specification extreme). These data are required to assess the thermal aspects of bolt stresses relative to the closure flange. (auth)

5487 (TID/SNA-2043) CRYOGENIC RADIATION DAMAGE IN STRUCTURAL POLYMERS. Dixon, C. E.; Funk, C. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1966. 52p. Dep. NTIS $5.75.

The useful service limitations of polymers and polymer-bonded laminates used for bearing retainer materials needed to be established to determine their suitability for the NERVA system. Materials investigated included two forms of Teflon-bonded glass cloth laminate (Armalon), a polyimide formulation filled with 15% MoS_2 and FEP Teflon. Tests were conducted with quadruplicate 0.125 inch thick tensile specimens in the General Dynamics Ground Test Reactor at doses of 1.1, 5.4 and 27×10^9 ergs/gm(C). Exposure was conducted in liquid hydrogen (−423°F) with tensile tests being performed at −423°F before and after warm up to room temperature. Room temperature tensile tests after warm-up were also made. The ultimate strength and ultimate elongation of the polyimide is not changed by a gamma dose of 27×10^9 ergs/gm(C)

when exposed in liquid hydrogen. Teflon of the FEP grade reaches a radiation threshold at 1.2×10^9 ergs/gm(C) in liquid hydrogen, suffers a 30% strength loss at 5.4×10^9 ergs/gm(C) and becomes too brittle to test after 27×10^9 ergs/gm(C). A comparison of these results with ambient temperature data indicates the radiation resistance of Teflon is greatly enhanced in a liquid hydrogen environment over an ambient air environment. Armalon suffers severe strength loss and delamination after exposure to 27×10^9 ergs/gm(C) with some strength loss at 5.4×10^9 ergs/gm(C), due to deterioration of the Teflon bonding. Annealing polymers irradiated at liquid hydrogen temperature to room temperature indicated no significant trend of properties that could be attributed to oxidation mechanisms. (auth)

5488 (TID/SNA-2060) ENGINEERING OPERATIONS REPORT: RECOMMENDED BRAZING PROCEDURE FOR NERVA NOZZLES. Spaletta, H. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Mar 1972. 7p. Dep. NTIS $4.00.

Experiments were conducted using ARMCO 22-13-5 forged plates, AISI 347 stainless steel coolant channels and AISI 347 shims to produce the simulated NERVA nozzles configuration. These assemblies were successfully assembled and furnace brazed using the procedures previously established. Variations of these procedures are discussed. The procedures recommended are not only for the ARMCO 22-13-5–AISI 347 combination but may be used for Hastelloy X, AISI 347, or ARMCO 22-13-5 alloy nozzle components. (auth)

5489 (TID/SNA-2076) FULFILLMENT OF PROJECT 620 WORK STATEMENT NO. 4 MILESTONE. Shurley, L. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 26 Jan 1972. 27p. Dep. NTIS $4.50.

Miscellaneous correspondence between SNSO-C and the two contractors on NERVA design details has been documented. Thirty six action items and comments by SNSO-C involve design decisions or suggestions for study, calculations, etc. of particular problems; in many cases, how to prevent, or correct for, malfunctions. A few of these suggestions involve the rest of the correspondence (location of impedance ring around reflector, forward reactor support design). (LTN)

5490 (TID/SNA-2078) NUCLEAR HEATING RATES IN THE PRESSURE VESSEL, FLIGHT ENVIRONMENT. Courtney, J. C. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 18 Jan 1971. 4p. Dep. NTIS $4.00.

The detailed specification extreme flight environment pressure vessel heating rates are documented. The nuclear subsystem used for these analyses contained the graphite core (worst case). (auth)

5491 (TID/SNA-2083) LN_2 AND LH_2 FRACTURE TOUGHNESS OF ARMCO ALLOY 22-13-5. Dessau, P. P. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 8 Apr 1971. 9p. Dep. NTIS $4.00.

Fracture toughness tests were performed in order to enable the ductile/brittle classification of the nozzle candidate material, ARMCO 22-13-5. One inch thick, precracked, compact tension specimens were fabricated from a $1\frac{1}{4}$ inch thick plate. A total of six specimens were tested to determine critical stress intensity parameters, KIC, in LN_2 and LH_2. Results indicated that the material was tough (ductile) at both temperatures according to the ductility criterion specified in SNPO-C-1. Fracture toughness, KIC, decreased from 84 KSI-$in^{\frac{1}{2}}$ at 140°R to 63 KSI-$in^{\frac{1}{2}}$ at 40°R, or exactly 25%. The material was classified as tough since the critical stress, σc, exceeded the material's yield strength at both 140°R and 40°R. (auth)

5492 (TID/SNA-2093) RESULTS OF DELTA WEIGHT CALCULATIONS BETWEEN 6061 AA AND 7075 AA PRESSURE VESSEL CLOSURES. Tracy, D. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 24 Aug 1971. 3p. Dep. NTIS $4.00.

A weight reduction of approximately 95 lbs can be realized by changing the pressure vessel closure material from 6061 AA to 7075 AA, with no significant effect on the fabrication process. Therefore, it is recommended that the prime closure material for the reference design be 7075-T73AA. This recommendation is made on weight and fabrication considerations only, and must be substantiated by analyses scheduled for the near future. (auth)

5493 (TID/SNA-2094) PRESSURE VESSEL AND CLOSURE DESIGN STATUS REVIEW. Shurley, L. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 18 Apr 1972. 55p. Dep. NTIS $5.75.

Material presented at a design status review of the NERVA pressure vessel and closure in May, 1971, has been documented. (LTN)

5494 (TID/SNA 2095) NERVA DETAIL SPECIFICATION. Part I. Performance/Design and Qualification Requirements for Pressure Vessel and Closure. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 16 Aug 1971. 71p. Dep. NTIS $6.75.

Detailed specifications and performance requirements (EC-90154B) are provided for the engine pressure chamber of the 75K, Full Flow NERVA Engine which contains the nuclear reactor, and provides support for propellant coolant lines, nozzle assembly, control drum actuators, wiring harness and instrumentation. (LTN)

5495 (TID/SNA-2096) NOZZLE EXTENSION DOCUMENTATION OF CARBON YIELD AND OTHER PROPERTIES OF CANDIDATE BINDER SYSTEMS FOR AGCarb COMPOSITES. Redfield, T. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 3 May 1972. 34p. Dep. NTIS $4.75.

Miscellaneous fabrication and processing data for the NERVA Nozzle Extension not previously reported nor specifically contained within the Final Report (ME-72-129) is documented. The data presented in both tabular and graphical form includes dimension and weight change and carbon yield information for impregnated fibrous graphite laminates and impregnant specific gravity and viscosity information at various processing steps. Laminate dimensional and weight change and mechanical property data summaries are also presented for selected candidate impregnant (binder) systems. Data are also presented in tabular form describing T bar specimen construction features and mechanical property test results. Each laminate is identified with a Process Identification Number (PIN). Complete processing history for each PIN is contained in PIN folders which are on file. (auth)

5496 (TID/SNA-2097) NOZZLE SKIRT EXTENSION DOCUMENTATION OF LAMINATE TEST DATA AS OF 1 JULY 1970. Swope, L. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). 13 Jul 1970. 29p. Dep. NTIS $4.50.

The measurements, weights and percent change for graphite fabric reinforced laminates after each processing step are recorded in 14 tables. The processing steps are: precure, post cure, carbonization and graphitization. (auth)

5497 (TID/SNA-2101) NERVA NOZZLE EXTENSION FIBROUS GRAPHITE DEVELOPMENT. Final Report. Davis, H. O.; Brown, J. A. (Aerojet Liquid Rocket Co., Sacramento, Calif. (USA)). 1 May 1972. 69p. Dep. NTIS $6.50.

The development of AGCarb fibrous graphite material systems is reported. Better interlaminar shear and block tensile strengths have been attained. Reliability and reproducibility problems were encountered in developing processing methods for different resins and/or reinforcements. The tensile strengths and variability of some typical products are given. (LTN)

5498 (TID/SNA-2102) STATUS REPORT ON PROPULSION/ELECTRIC POWER. Beveridge, J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 16 Mar 1972. 15p. Dep. NTIS $4.00.

The status of NERVA reactor development for both propulsion and electric power is reviewed. The studies have shown that there are advantages in such combined systems, since the reactor heat used for electric power allows some savings in propellant that would otherwise have to be used during cooldown. Even for a long period of time the electric power requirement is only a very minor fraction of that required for propulsion. The studies indicate a complex relation between the optimum size of electrical system and the payload advantage, which depend on the mission and rocket size. The dual mode electric power generation system weight increases with increased power generation capability. The amount of cooldown fluid saved also increases with increased size of the dual mode system. The 25 KW(e) system is larger than optimum for lunar missions which do not need the 25 KW(e) power. A 10 KW(e) system is more nearly optimum from a cooldown-payload standpoint. Payload increases to lunar orbit of 2000 to 7000 lb can be obtained based upon the assumption that cooldown impulse is not utilized. If the cooldown impulse can be utilized, the payload gain ranges from 0 to 4000 lb. (auth)

5499 (TID/SNA-2103) ENGINEERING OPERATIONS REPORT: PROPULSION/ELECTRICAL POWER GENERATION. Final Report. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Jun 1972. 79p. Dep. NTIS $7.00.

The feasibility of utilizing the NERVA engine as a heat source for a 25 KW(e) electrical power system was investigated. A minimum number of additions to the NERVA engine to perform the dual function was maintained as a basic ground rule. Several concepts for removing heat from the engine were evaluated. The

final system selection was not changed however. It consists of a closed loop, independent of the normal NERVA flow path, primary coolant circuit which carries heat from the engine to the forward end of the stage where the hydrogen coolant supplies heat to a boiler (vaporizer). An organic working fluid, thiophene, was selected as the most desirable fluid for the Rankine-cycle power conversion system. A wick-type condenser is used for the zero gravity environment. The heat rejection system utilizes gaseous hydrogen flowing in closed parallel loops to conduct heat from the condenser to the exterior of the stage. Off-design operation of the system during the early portion of the cooldown for the NERVA engine was investigated. This enhanced the cooldown hydrogen savings and made the dual mode concept even more desirable. Consideration of dual mode systems larger and smaller than the 25 KW(e) system showed that a 10 KW(e) resulted in the maximum payload for a lunar mission provided the need for electric power was not more than 10 KW(e). In other words, the dual mode system size optimization was based upon cooldown propellant savings only. (auth)

5500 (TID/SNA-2170) ENGINE COOLDOWN PRELIMINARY ANALYSIS. Smalec, L. M. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 13 Dec 1971. 8p. Dep. NTIS $4.00.

Possible gains are obtainable by redesigning the reflector to dissipate more decay power and thus allow ending use of hydrogen for cooldown sooner. The effects are estimated for a standard 400 E engine, with the redesigned reflector and for dual propulsion-power engine designs. (LTN)

5501 (TID/SNA-2179) ENGINE COOLDOWN SCOPING STUDY. Smalec, L. M. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 6 Oct 1971. 23p. Dep. NTIS $4.25.

Cooldown is that phase of NERVA engine operation which begins after initial turbopump shutdown following an engine burn, and during which time the engine must be cooled by expending propellant to dissipate nuclear afterheat. The performance requirements for engine cooldown are reviewed, and problem areas with the 1137400/E reference engine are identified. Design modifications which might be incorporated to alleviate these problems are evaluated. (auth)

5502 (TID/SNA-2181) DUAL PUMP START-UP STUDY (START-UP CAM). Dryden, R. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1971. 17p. Dep. NTIS $4.00.

Difficulties in starting dual turbopump systems were studied with the Common Analog Model. The problem resulted from one pump having all the engine flow in the initial stages, so the pump with zero flow would not chill down and would be in a stalled condition when the bootstrap was initiated. For the CAM system and the turbopump representation used, both pumps did eventually come on-line, but there remain some problems with respect to the adequacy of the low speed and low flow rate representation of the actual pump performance. (LTN)

5503 (TID/SNA-2189) RECIRCULATION OF FLOW TO THE TANK. Madsen, W. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 1 Nov 1971. 3p. Dep. NTIS $4.00.

It is suggested that the payload advantage calculated in N8610: 069M for the recirculation of some hydrogen flow back to the tank during NERVA reactor startup and shutdown (as a means of avoiding pump stall conditions) is overly optimistic. The calculation did not allow sufficiently for the extra piping (greater than 3½ in. I. D.) and fast acting valves required, nor for possible effects of two phase flow or of bubbles in the tank. The author is in favor of the recirculation system to keep the pumps out of stall conditions during startup and shutdown, but feels the idea should be sold on the basis of making the system work and work safely being the major advantage with the possible increase in payload a secondary advantage. (LTN)

5504 (TID/SNA-2202) ENGINEERING OPERATIONS REPORT: COMMON DIGITAL MODEL REQUIREMENTS. Buden, P.; Stiger, R. R.; Wells, R. A.; Madsen, W. W.; Pierce, B. L. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Oct 1971. 70p. Dep. NTIS $6.50.

The requirements for performance, design, test, and qualification of a computer program identified as the Common Digital Model (CDM) are described. This computer program is used to accomplish analysis of the baseline NERVA nuclear rocket flight engine system but will retain sufficient flexibility to analyze variations in the baseline engine system. The CDM is used to analyze all phases of engine behavior including engine conditioning, thrust buildup, steady state, shutdown and cooldown. The formulae incorporated in the program are given, but the program itself is not listed. (auth)

5505 (TID/SNA-2214) DEVELOP ANALOG MODELS AND PERFORM ENGINE SYSTEMS STUDIES. (Aerojet-General Corp., Sacramento, Calif. (USA)). 16 Mar 1972. 8p. Dep. NTIS $4.00.

Analog models of engine configurations (including startup and power range operation) were developed for systems and controls analysis and necessary systems studies required to support engine design for configuration evaluation, malfunction studies, component specifications, controllability studies, static stability and an understanding of basic system behavior. The engine steady state analysis has been updated for the 1137400E engine to reflect changes in lines, valves and nuclear subsystem components. A complete update of state points is underway for completion in April 1972. Studies on transients are underway but the results are of a preliminary nature. Most of the work to date has been to develop techniques for the solution of shutdown and cooldown problems. Studies were made on the Common Analog Model on system behavior, valve specifications, effect of graphite core and engine uncertainties. State points data has been generated for the 1137400E reference engine for all normal, single-turbopump, and emergency steady-state operating conditions. Data included the effect of component design, manufacturing, and test uncertainties to generate specification extremes for all components. Studies were performed on malfunctions in order to establish an emergency operating point that can be reached with a large number of component failures. (auth)

5506 (TID/SNA-2245) BYPASS CONTROL VALVE SEAL AND BEARING LIFE CYCLE TEST RESULTS. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Apr 1972. 52p. Dep. NTIS $5.75.

The initial leak and torque test results of the Bypass Control Valve (BCV) revealed that, if the visor seal is aligned with the visor, the specification leakage requirements will be satisfied even though total sealing interface conformance has not been achieved. Initial cycling tests indicated that far more than 200 cycles would be required to improve conformance by wearing in the seal to match the visor surface. The proof and deflection tests disclosed that the basic structural design is adequate to withstand design proof pressures without failure or permanent distortion. Correlation between the deflection data obtained and the preliminary stress analysis was not possible because of a lack of information. The seal and bearing life cycle tests were completed and the planned cycle life of 120 thousand cycles was obtained. The visor seal GHe leakage rate decreased during the tests to several orders of magnitude lower than the specification requirements. Although the measured torque was higher than predicted the tests were concluded to be more severe, in terms of factors tending to increase torque, than would be experienced during engine operation. Disassembly of the valve revealed no part failure or galling. Scoring occurred at the seal to visor sealing interface and at points of maximum load where the bearing balls had worn through the gold plated race surfaces. The wear on all other valve parts was insignificant. The results of the tests completed thus far indicate that with some development the basic BCV design would fulfill the intended engine operating requirements. (auth)

5507 (TID/SNA-2296) DEVELOPMENT TEST REPORT OF KIWI-B AND HYBRID NOZZLES. (Aerojet-General Corp., Azusa, Calif. (USA)). 22 Mar 1963. 106p. Dep. NTIS $8.50.

Declassified 10 Sep 1973.

The failure of two NERVA-type nozzles (KIWI-B, S/N 002K and Hybrid, S/N 001H) during hydrostatic tests has been investigated. Poor casting quality was found in the areas which failed (usually evidenced by porosity). The chemical composition was within specifications and specimens machined from non-failed areas were within material specifications. In the failed areas, specimens failed during machining or, if they survived machining, failed at low tensile strengths with little yield before failure (this explains why strain gages used during the hydrotest gave no indication of the approaching failure). The defective areas were characterized by shrinkage and a needle-like eutectic microstructure containing considerable coarseness. Coarseness is detrimental to strength and the needle-like structure is detrimental to ductility. Changes in the casting procedure are recommended. (LTN)

5508 (TID/SNW-39) LASL-WANL FLOUR AND PROCESS COMPARISON. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 12p. Dep. NTIS $4.00.

Declassified 11 Sep 1973.

It has been shown that fuel elements extruded at LASL have less individual bore corrosion problems than those produced at WANL. This problem will not limit the life of Pewee-II under the presently planned test program of six ten-minute cycles. However, R-1

will not meet its objectives if the individual channel corrosion is not solved. This planned experiment is aimed at providing baseline information for the understanding of the bore corrosion problem and at giving direction for further R-1 matrix development programs. Presently, there are two plausible theories that may explain the differences in the performance of the LASL and WANL elements. Both theories seem to have about equal theoretical and factual background. One theory centers around the basic differences in the flours used by the two manufacturers, while the other theory concerns extrusion process differences. LASL uses a flour which is slightly finer, more graphitic, and more anisotropic than the WANL flour. LASL also uses a much higher extrusion rate than does WANL. Either of these differences may cause individual channel corrosion problems. The proposed experiment is an attempt to prove which, if either, theory is correct and to act as a guide for further R-1 channel investigations. (auth)

5509 (TID/SNW-50) DESTRUCTIVE TESTING (PHASE III) OF ELEMENTS REPRESENTING NRX-A5. Summary of Results. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 24 Aug 1966. 87p. Dep. NTIS $7.50.

Declassified 7 Sep 1973.

Fueled and unfueled elements, representing those furnished by Astrofuel and Y-12 for NRX-A5, were selected and destructively tested in accordance with the requirements of their governing specifications. The destructive tests performed included the following: impurities and negative reactivity, hydrogen, density, uranium, niobium and carbon loading, bore coating thickness (metallographic), fuel coating thickness and migration, flexural strength, thermal expansion, and hole location. The results of this testing program are presented in a series of tables. With minor exceptions, all specified requirements were met. Certain trends (e.g., of uranium loading) were found, which were significant but within the specified range. The calculation of negative reactivity from spectrographically determined impurities presented problems due to the minimum detection limits of the available equipment. The results presented are extensive and detailed. (auth)

5510 (TID/SNW-56) MONTHLY REVIEW OF PROJECTS 721 AND 783. Sanderson, A. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Jan 1971. 111p. Dep. NTIS $8.75.

Declassified 10 Sep 1973.

Fuel element research was reviewed as follows: composite element fabrication and processing; coating development; hydrogen corrosion testing; quality control; and development approaches with respect to flours, binders, carbon blacks and the graphitizing process. (LTN)

5511 (WANL-PR(J)-036) NERVA NUCLEAR SUBSYSTEM. Progress Report, October 1, 1964–December 31, 1964. Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jun 1965. 290p. Dep. NTIS $17.50.

Declassified 10 Sep 1973.

The major accomplishment was the successful completion of the NRX-A2 Restart Test performed on October 15, 1964. The reactor was operated at a constant power level of 40 MW for approximately 2½ minutes. In addition to demonstrating the feasibility of restarting the NRX-A2 reactor, the following objectives were met: Stable operation at low flow rates resulting from Dewar pressurization with no pump power and at substantial chamber temperatures; stable operation with two phase flow conditions at the core inlet; and stable operation with control drums fixed and power responding to flow changes. Also during this period data from this test and previous tests were analyzed. The basic conclusion is that the reactor performs at expected design levels and that no deleterious vibrations are indicated. However, the test data also suggests that problems continue to exist both in the measurement system and in the data analysis equipment. It appears initially that velocity measurements have certain advantages over acceleration measurements. Activity in the NRX-A3 area included the preparation of the test prediction report. Present test plans call for a 15 minute full power run, a 5 minute full power restart, liquid hydrogen pulse cooling for decay heat removal, low power–low flow testing, and a reactor startup with fixed control drums to intermediate power. Activity in the NRX-A4 area included the calculation of the temperatures of the fuel element orifices, the orifice cement, and the fuel element at the core inlet. Activity in the NRX-A5 area included analyses of the thermal and fluid flow operating characteristics of the reflector and lateral support system for full power operation and 75.7 lb/sec coolant flow. Possible design changes to the NRX-A5 to reduce core pressure drop and fuel temperatures are being investigated. Changes being considered include radial power flattening, increased channel diameters, use of as-extruded fuel elements, and re-orificing the tie rod channels. Activity in the NRX-A6 area consisted of the preparation of a preliminary test request and instrumentation list. The major objectives of the NRX-A6 test are: Operation at full power for an integrated time of 40 to 60 minutes; startup and shutdown at a rate of change of chamber temperature of 150 R/sec along tie rod and chamber temperature limits; acceptability of design changes and hardware modifications; and operation at higher than design power by increasing chamber temperature and/or flow rate for a short interval of time. (auth)

5512 (WANL-PR(J)-044) NERVA NUCLEAR SUBSYSTEM. Progress Report, 1 October 1966–31 December 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 Jan 1967. 175p. Dep. NTIS $11.75.

Declassified 11 Sep 1973.

Successful tests during the past two years of three NERVA reactors–NRX-A3, NRX-EST and NRX-A5–have been followed by a fuel development and assessment program directed towards a better reactor with extended core life at full power. The reactor tests have been followed by intensive analyses of an almost endless stream of test data. The conclusions are being carefully weighed and documented along with the data. At the same time, feedback of the data needed to improve the product is being made directly to the cognizant laboratory. In the NRX-EST and NRX-A5 tests, there was evidence of corrosion of fuel elements. Fast response to the challenge presented by the corrosion phenomenon resulted in the in-house test program of fuel assessment now in process. Westinghouse engineers have conducted almost 500 single element hydrogen corrosion tests in the last quarter alone. Present plans call for a 31 August 1967 testing of the NRX-A6 reactor. (auth)

5513 (WANL-PR(J)-048) NERVA NUCLEAR SUBSYSTEM. Progress Report, 1 October 1967–31 December 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jan 1968. 172p. Dep. NTIS $11.75.

Declassified 11 Sep 1973.

The successful test of the NRX-A6 reactor on 15 December 1967 was the highlight of the quarter at WANL. This reactor ran for slightly over an hour at conditions which appear to have averaged slightly above design temperature and power, as deduced from measured exit gas and in-core temperatures and from the nozzle flow relationship. Disassembly of the reactor is presently proceeding at the R-MAD Facility at NRDS. Although cracking of the reflector and some filler strips remains to be fully explained, the condition of the reactor appears to be excellent judging from the data to date. Tests of fuel elements with hydrolysis and defects expected to be worse than those in XE-1 lead to the conclusion that the reactor was still capable of appreciable operation at full power. Assembly of the engine system has proceeded at NRDS. During checkout of the Control Drum Actuators two were damaged by faulty operation of the facility pneumatic system. This has been corrected and checkout of the actuators is proceeding. Fuel production for XE-2 has been proceeding on a schedule consistent with a 15 June 1968 shipping date of the reactor assuming that current yield figures continue to be achieved. The reactor hardware is essentially in hand, although some is still in inspection. The start of clustering has been delayed to allow the incorporation of several modified fixtures and techniques to retard hydrolysis. Fuel elements and associated hardware for PEWEE-1 are in various stages of manufacturing aimed at an April 1968 shipping date to LASL. Planning is underway for the provision of experimental fuel for PEWEE-2 which will be aimed at the R-1 reactor conditions which have recently become more firm. Effort on NERVA-II related tasks was terminated at the direction of SNPO. Design and analysis effort related to a 75,000 lb thrust NERVA-1 engine have proceeded in support of the joint SNPO/AGC/WANL Task Force. A reference reactor design has been chosen and is being worked on preparatory to a preliminary design review to be held in CY'1968. A Configuration Management system based upon the principles of the AFSCM 375 series of documents is being implemented in conjunction with AGC as this program develops. (auth)

5514 (WANL-PR(J)-049) NERVA NUCLEAR SUBSYSTEM. Progress Report, 1 January 1968–31 March 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Apr 1968. 172p. Dep. NTIS $11.75.

Declassified 11 Sep 1973.

The successful test of the NRX-A6 reactor on 15 December 1967 gave added impetus to engineering effort during the past quarter. Analysis of the copious stream of data both on-line and from post-operative examination continued. Reactor disassembly is complete. Detailed reports relative to the NRX-A6 nuclear subsystem are now being prepared in draft form. Fuel elements and associated hardware for PEWEE 1 are in various stages of final inspection and test aimed at an April 1968 shipment schedule. An agreement relative to WANL requirements for PEWEE 2 has been reached, production of fuel will commence

in June. Preparations were finalized for assistance in the flow test of the XECF system. WANL participated in the vibration testing program during this quarter. The XE-1 nuclear subsystem previously delivered to NRDS was being assembled into the engine system in the E-MAD building at NRDS at the close of the quarter. Readiness Reviews of all WANL supplied components have been held; the resulting action items are in work. The XE-2 reactor is scheduled for shipment to NRDS on 15 June 1968. Orificing of fuel elements has been completed; clustering and stacking operations will begin in April 1968. Design and development testing of the R-1 reactor has continued. Specifications and other configuration management data items are in preparation; many will be published in the next quarter. (auth)

5515 (WANL-PR(J)-058) NERVA NUCLEAR SUBSYSTEM. Progress Report, 1 April 1970–30 June 1970. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jul 1970. 85p. Dep. NTIS $7.25.
Declassified 11 Sep 1973.

5516 (WANL-TME-028) RADIATION LEVELS FROM ACTIVATED ENGINE COMPONENTS. Ricks, L. O. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 9 Mar 1962. 3p. Dep. NTIS $4.00.
Declassified 10 Sep 1973.
Gamma radiations from selected components (reflector, shield, support plate) of a PHOEBUS reactor, which has been operated at 4000 MW for 1 hour, have been calculated for 24 and 60 hours after reactor shutdown. The activation calculations represent a maximum value since they are based on the maximum concentration of each constituent. (LTN)

5517 (WANL-TME-319) SELECTION OF NRX-A TIE ROD MATERIALS. Hoppe, A. W.; Harrod, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 17 Oct 1963. 43p. Dep. NTIS $5.25.
Declassified 11 Sep 1973.
The selection of tie rod material for the NRX-A test series is based primarily upon mechanical properties, particularly load-bearing ability at both high (~1200°F) and low (~–250°F) temperatures. Of eleven candidate materials (Inconel 718, 17-7 PH, René 41, D-979, W-545, Hastelloy R-235, Incoloy 901, A-286, Discaloy, Inconel X-750, and Inconel 702 in order of decreasing yield strength) only 17-7 PH is considered to be definitely unsuitable. The 17-7 PH alloy was eliminated because of: its inadequate yield strength at temperatures above 800°F, and its propensity to brittle fracture behavior at cryogenic temperatures. All of the remaining alloys have no inherent tendency to brittle fracture at cryogenic temperatures and are potentially suitable for tie rods. These alloys are all quite similar with respect to composition and microstructure and their properties can be viewed as a spectrum of tensile yield strength which ranges from Inconel 702 and Inconel X-750 on the low side up to Inconel 718 on the high side. Inconel X-750 was selected as the primary material choice because its mechanical properties are adequate, and early irradiation effects data available for this alloy showed no significant deleterious effects on properties. Inconel 718 was selected as a back-up material because, being the strongest, it allows the greatest margin for future increases in design requirements. While the reasons for selection of Inconel X-750 and Inconel 718 are sound, the reasons for elimination of other candidates (except for 17-7 PH) were not so serious as to preclude any possible use in this application. (auth)

5518 (WANL-TME-334) PRELIMINARY STRESS ANALYSIS OF NRX-A LATERAL SUPPORT SYSTEM. Downs, G.; Swanson, J.; Pianka, E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 May 1963. 69p. Dep. NTIS $6.50.
Declassified 11 Sep 1973.
The stress analysis was conducted in parallel with the heat transfer analysis, therefore, the temperature values used in the stress calculations are not necessarily consistent with the final temperature distributions. In some cases, such as the filler strips where stress is strongly dependent on the temperature and pressure gradients, stress was calculated as a function of temperature and pressure in order that combinations of allowable pressure and temperature would be more readily determinable once they are firmly established. In the analysis, it was conservative to compare operating stresses to room temperature material allowables as graphite components operate above room temperature where they are stronger and metals components operate below room temperature where they have higher strength. Therefore, the stress analysis represents a conservative evaluation of the structural adequacy of the lateral support system components. (auth)

5519 (WANL-TME-341) EVALUATION OF USE OF UCRL HOT-BOX FACILITY AT NTS FOR SOLUTION OF NERVA PROBLEMS. Gallagher, J. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1963. 18p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
A review of NERVA reactor problems indicated that either a Preassembly Type Critical Experiment and/or Clean Flexible Critical Experiments should be performed at elevated temperatures in support of the NERVA Program. The information from such experiments will permit a reduction in the uncertainty in the cold to hot reactivity change, operating drum position and shutdown margin, and operating power distribution and peripheral fuel element temperatures. A more detailed study would be required to select the best type of experiment from the schedule, information, and cost standpoint. (auth)

5520 (WANL-TME-345) DESCRIPTION AND HAZARDS ANALYSIS OF FIRST SERIES OF THERMAL STRESS EXPERIMENTS ON NERVA FUEL MATERIAL IN TREAT. Vogel, M. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 8 May 1963. 14p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
The purpose of this series of experiments is to evaluate the ability of NERVA graphite fuel elements to withstand thermal stresses. The first objective of the program is to establish that NERVA fuel can satisfactorily operate at rated power output of 4 KW/cm^3 without suffering thermal stress cracking. The second objective is to establish what combination of thermal gradients and temperature level will result in fuel cracking. The general sequence of the experimental work will be pre-irradiation measurements and tests on the fuel material, assembly and test of equipment followed by irradiation in the TREAT reactor. After irradiation the autoclaves will be returned to the Astronuclear Laboratory for post-irradiation evaluation of the fuel material. (auth)

5521 (WANL-TME-358) DETERMINATION OF NRX-A LATERAL SUPPORT SPRING RATE. Downs, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 Jun 1963. 9p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
An analysis of the lateral support spring system in the NRX-A Reactor Core assembly contains the derivation of an equation which relates the force necessary to move the core laterally with respect to the Inner Reflector. The core consists of regular fuel element clusters suspended from the support plate by tie-rods, surrounded by irregular clusters, and by filler strips which transpose the periphery from an irregular shape to a circle. Seal segments backed by lateral support springs acting through the Inner Reflector Cylinder surround the elements and exert a bundling force on the core. In this analysis a unit length of the core is considered as a solid cylinder located within the Inner Reflector by preloaded radial springs. The effects of the tie-rods on the lateral movement of the core is neglected in this analysis. Based on the expression derived, the NRX-A lateral support spring system is defined. Assuming a coefficient of friction of .25, the NRX-A lateral support system, with a spring rate of 137 lbs/in. at each plunger, can react 4 "G" steady acceleration of the core in .200 inch deflection. The resisting force of the spring system is dependent upon friction, and a curve showing the variation of this force with respect to the coefficient of friction is presented. (auth)

5522 (WANL-TME-364) NRX-A POSSIBLE CORE SEPARATION. Downs, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 Jun 1963. 9p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
An analysis of element separation within the core when the reactor is subjected to a steady lateral accelleration load has been made. The mode of element separation is the result of a tendency for the core to split along the diameter and separate into halves. The assumption is that if this occurs the elements could break or that axial gaps could remain between elements in the core when the lateral acceleration load is removed. Using the spring system constants that were derived in WANL-TME-358, and the equation relating the parameters of the spring system to the coefficient of friction derived in this analysis, it is proven that the core will stay bundled for the mode considered if the coefficient of friction is less than .714. (auth)

5523 (WANL-TME-366) NRX-A2 SHIELD REPLACEMENT UNIT RADIATION ANALYSIS. Stephenson, L. D.; Ricks, L. O. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1963. 32p. Dep. NTIS $4.75.
Declassified 11 Sep 1973.
Radiation and heating rate data are presented for the NRX-A2 with the aluminum shield replacement unit. Specific analyses

performed include: Development of heat generation rates in the NRX shield replacement unit; calculation of fast neutron and gamma radiation levels outside the pressure vessel; and evaluation of residual activity levels of a KIWI test car due to exposure to a five-minute full power firing of the NRX-A2. (auth)

5524 (WANL-TME-378) NRX-A REACTOR VIBRATION AND SHOCK TEST PLAN. Miller, D. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 May 1963. 57p. Dep. NTIS $6.00.

Declassified 11 Sep 1973.

The test plan, test objectives and schedule of the integral reactor mechanical vibration test program are described. The program is described in WANL-TNR-095, NRX-A Component Test Program, and designated E-1, Reactor Assembly Mechanical Tests. While the exact nature of the excessive vibration conditions which might be applied to the reactor assembly have never been defined, it is presumed that these tests would involve higher levels of excitation than design conditions, at resonant frequencies of importance, and dwell times in excess of normal design conditions. The significance of such testing is to establish the ultimate capability of certain reactor parts with respect to stress levels. (auth)

5525 (WANL-TME-403) PRELIMINARY REPORT ON AIR FLOW TESTS FOR CONTROL DRUM DRIVE SHAFT LOSS COEFFICIENTS. Jacob, W. L. (Westinghouse Electric Corp., Pittsburg, Pa. (USA). Astronuclear Lab.). [nd]. 18p. Dep. NTIS $4.00.

Declassified 10 Sep 1973.

Pressure loss coefficients are required for the coolant flow paths along the control drum-drive shaft of the NERVA reactor for design and off-design conditions. The flow rate must be determined through the drive shaft flexible couplings and exhaust holes; nozzle end bearing shaft holes and plenum; inner two rings of control drum coolant holes; and the dome end bearing shaft. The effects of drive shaft exhaust hole size, nozzle end plenum depth, and nozzle end ring clearance, on flow must be determined. Measurements of the loss coefficients and determination of the flow distribution are necessary for correct sizing of (a) the drive shaft and nozzle end plenum holes, (b) nozzle end control drum plenum, and (c) the other coolant passages. This knowledge is necessary to insure a safe thermal environment for the control drum during maximum power output of the NRX-A hot tests. The results of preliminary air flow tests on the first control drum-drive shaft model are summarized, and the new version of the test model and the new instrumentation and run program are described. Modification of the test setup were made because internal leakage within the pressure measurement system were encountered in the original equipment. (auth)

5526 (WANL-TME-466(Add. 2)) CANDIDATE TRANSDUCER DATA SHEETS FOR INSTRUMENTATION DATA BOOK. Teyssier, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 26 Dec 1963. 366p. Dep. NTIS $21.50.

Declassified 10 Sep 1973.

5527 (WANL-TME-570) NRX-A2 POST FIRING COOLING REQUIREMENTS. Kutilek, J. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 16 Oct 1963. 17p. Dep. NTIS $4.00.

Declassified 11 Sep 1973.

A detailed study was made of the cooling requirements of NRX-A2 after shutdown following a 5 minute full power run. The problems were complicated by plans to move the reactor from test cell "A" to the E-MAD building after the run. It is concluded that LH_2 should be used as long as possible (to conserve GH_2 pressure in the tank farm). But after about 98.6 seconds the core inlet temperature approaches 90°R and further liquid flow is undesirable because high density hydrogen could enter the core and increase its reactivity. Therefore, GH_2 flow is initiated at 90 seconds at 30 lb/sec, but the flow can be reduced rapidly to 4 lb/sec (the minimum required to prevent flow instability in the core). At 1500 sec GH_2 at 540°R is started at a rate of 7 lb/sec and continued for 6.7 hours (total available 540°R N_2). Flow of GN_2 at 200°R is continued from 6.7 hours to 24 hours. At this point the reactor is subcooled enough to allow disconnection and transfer on the test car to the MAD building—within 3 hours—if air is drawn through the core. Some forced convective coating through the core will be required at the MAD building. Forced cooling will not be required when the fuel clusters have been removed. (LTN)

5528 (WANL-TME-608) EFFECT OF NRX-A2 FLUID CHANGEOVER ON OUTER REFLECTOR TEMPERATURE DISTRIBUTION. Howarth, W. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 2 Dec 1963. 8p. Dep. NTIS $4.00.

Declassified 11 Sep 1973.

Since Aerojet-General Corp. calculated a rapid propellant changeover from 90°R hydrogen to liquid hydrogen at about 47 percent of rated power would cause severe temperature gradients in the outer reflector, Westinghouse made further calculations. It was found that the temperature gradients in this operation were not large and were actually lower than gradients experienced in the cool down part of reactor startup. Further, much larger temperature rates of change were observed in the beryllium sectors in the KIWI cold flow tests with no apparent harmful effects. (LTN)

5529 (WANL-TME-636) NRX-A RADIATION LEVELS AT 10 FEET FOR TANK HEATING CALCULATIONS. Capo, M. A.; Nassano, R. N.; Stephenson, L. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1964. 33p. Dep. NTIS $4.75.

Declassified 10 Sep 1973.

The data presented are based on a consistent treatment of core gamma rays, extra-core gamma rays generated by neutron capture and neutron inelastic scattering by materials outside the active core, and neutrons. The sources, geometry, and number densities describing the three configurations are available in WANL-TNR-128, Vol. II. Radiation levels presented show that the centerline gamma ray attenuation factor for the flight shield is 21, and for the aluminum shield, 18. These gamma ray attenuation factors include the effects of extra-core gamma radiation. The centerline fast neutron (E > 1 MeV) attenuation factor for the flight shield is 675, and for the aluminum shield, 16. The overall effectiveness of both shields cannot be validly determined until tank heating data are generated. Gamma ray dose rates at a distance of 10 feet from the center of the NRX-A reactor for polar angles varying from 0° to 45° are presented in Tables. The dose rate data are given for both gamma rays originating in the active core and extra-core gamma rays. Thirteen source energy groups were used in the gamma ray analysis and the data are further subdivided according to these source groups. Neutron spectra have been calculated at 10 ft distance and for various polar angles. (auth)

5530 (WANL-TME-653) STRESS ANALYSIS: NRX-A INNER REFLECTOR AND ALUMINUM BARREL. Downs, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1964. 69p. Dep. NTIS $6.50.

Declassified 12 Sep 1973.

The stresses produced in the NRX-A aluminum core barrel when it is used as an assembly and handling fixture are defined. Both the stresses and deflections experienced in the barrel and inner reflector cylinder due to pressures and temperatures encountered at steady-state, full power operation are determined. (auth)

5531 (WANL-TME-669) TEST SERIES C 1: AN EXPERIMENTAL DETERMINATION OF THE PRESSURE LOSS COEFFICIENTS FOR THE INNER REFLECTOR–OUTER REFLECTOR ANNULUS USING AIR. Amatangelo, V. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 29 Jan 1964. 94p. Dep. NTIS $7.75.

Declassified 12 Sep 1973.

The inner impedance ring primarily meters the flow in the annulus between the inner and outer reflector and permits the flow in the annulus to be balanced with the rest of the entire reflector system. The impedance ring minimizes the problems of temperature distribution and mixing of non-isothermal hydrogen from the various parallel flows in the reflector system. The results of flow tests on a model of a 10° sector of the inner impedance ring conducted with air at ambient temperature and 120 psig inlet pressure are summarized. (auth)

5532 (WANL-TME-670) ANALOG COMPUTER ANALYSIS OF SPLIT FLOW CONTROL IN NRX-A1 TEST. Buker, J. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 29 Jan 1964. 23p. Dep. NTIS $4.25.

Declassified 12 Sep 1973.

An analog computer study of the proposed NRX-A1 split flow experiment was made. The purpose of the study was to determine the feasibility of satisfying the test specification using manual control or, if automatic control was desirable, to assist in the design of such a control system. The computer investigation of the split flow test, which is designed to produce core and reflector pressure drops equivalent to those for a power run using ambient hydrogen, indicated that specified flow and pressure demands could be maintained using manual control. The mathematical model used in the analysis is described and the results which led to the above conclusion are discussed. (auth)

5533 (WANL-TME-677) FURTHER RESULTS OF A THEORETICAL FLOW-VIBRATION MODEL. Mattson, T. B.

(Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 4 Feb 1964. 14p. Dep. NTIS $4.00.
Declassified 12 Sep 1973.
The results of a number of runs made using the "Flow Vibration Program" discussed in Part II of WANL-TME-447 are described. The computer program determines the one-dimensional motions of a set of rods hinged at one end (the inlet, or cold end); each pair of rods is separated by a prescribed gap thickness when in equilibrium. The motions of the rods are the result of a fluid flow between them. The input parameters for the runs made using this program were primarily chosen to study the effect of seals located on the left and right ends of the set of rods, either at the top (inlet, or cold end) or the bottom (outlet, or hot end). A spectrum analysis was done on the results of the computer runs, similar to the analyses of actual experiments in Part I of WANL-TME-447. The most significant results of the analyses of the runs were the following: (1) the bottom seals significantly reduced the relative amplitudes of those vibrations present during the runs; (2) the insertion of bottom seals on the left and right ends resulted in a bundling of the rods; (3) the insertion of top seals on the left and right ends had varying effects, none of which were favorable. A detailed discussion of the runs made, and the quantitative and qualitative results of their analyses are given. (auth)

5534 (WANL-TME-700) TEST REPORT ON A WANL RADIATION TEST OF NERVA COMPONENTS (GTR TESTS 7 AND 7A). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 2 Mar 1964. 57p. Dep. NTIS $6.00.
Declassified 12 Sep 1973.
Candidate NERVA instrumentation was irradiated ((1–200) 10^{18} n/cm^2 and (3–100) 10^{19} erg/g(c) gamma). More than 100 different instruments of 9 types and with different model design and manufacturer, in most cases, were irradiated. Detailed results are given. (LTN)

5535 (WANL-TME-760) CRITICALITY OF NRX-A FUEL LATTICES. Vachon, L. J. (Westinghouse Electric Corp., Pittsburg, Pa. (USA). Astronuclear Lab.). 30 Apr 1964. 13p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
Various phases in the NERVA program require the processing of relatively large numbers of enriched NRX-A fuel elements. Protection against inadvertent criticality during these operations requires that restrictions be imposed on the environment and on the quantity of elements that may be safely handled at one time. In order to establish nuclear safety limits under "always-safe" conditions, a criticality study was performed on water-moderated and reflected lattices of NRX-A fuel elements. A nominal value of thirty (30) NRX-A fuel elements of either type (design or in-process) is the minimum number of elements required for criticality under flooded conditions; this minimum value occurs at the atomic ratio $H/^{235}U = 250$ which corresponds to an edge–edge spacing of approximately 2 cms. When a particular lattice spacing can be assured by some physical means, the pertinent critical number of elements can be obtained from figures. Safety parameters for other configurations such as slab arrays or half-length fuel elements may be derived from the curves of material buckling and reflector savings presented in figures. For a close-packed spacing of design fuel elements (H/U = 22), the critical number of fuel elements in a cylindrical configuration is approximately 200; the corresponding critical radius is on the order of 15 cm. (auth)

5536 (WANL-TME-861) EVALUATION OF THE GRAPHITE COMPONENTS IN THE NRX-A2 LATERAL SUPPORT SYSTEM. Saccocio, R. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1964. 20p. Dep. NTIS $4.00.
Declassified 11 Sep 1973.
The lateral support system has three basic mechanical functions; to bundle the NRX-A reactor core during steady-state operation, to provide a distributed seal system about the core periphery, and to absorb steady and dynamic lateral loads to and from the core during shipping and engine operation. The accomplishment of these functions is by means of a series of equally spaced rings that surround and bear against the core. These rings are made up of segments which are held against the core by spring-loaded plungers. The lateral support plungers are guided by holes drilled in the inner reflector cylinder. A potential wear problem exists because of component material (graphite) and due to the relative motion between the segments and the plungers and the plungers and the cylinder. This report is an evaluation of the wear resistance of the inner reflector cylinder, the support plungers, and the seal and retainer segments. In the original designs a high point loading on the conical end of the plunger led to wear, but wear has been superficial since the parts were redesigned. (auth)

5537 (WANL-TME-999) FFL-2 TEST REPORT RESULTS AND ANALYSIS OF INITIAL TESTS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 55p. Dep. NTIS $5.75.
Declassified 10 Sep 1973.
The purpose of the initial test series on the simulated heated seal system was to determine the adequacy of the analytical techniques used in the determination of the thermal and hydraulic characteristics of the lateral support system of the NRX-A reactors. The test configuration was analyzed by the same basic methods and techniques used for the reactor lateral support system. When the hot seal analytical results were compared to the experimental data, the hydrogen flow rate was found to be within 20 percent and the gas temperature rise to be within 10 percent. This discrepancy is possibly attributed to the leakage between the seal lands and the outer barrel. The material temperature levels determined by analysis showed a maximum deviation of 80°R from the test data. This deviation is largely attributed to uncertainty in the boundary conditions existing in the test configuration and the uncertainty of the relationship of the experimental temperature measurements to mean temperatures. Thus, on the basis of the agreement of the analysis with the data obtained in the first series of tests on the heated seal configuration, the level of confidence in the analysis of the reactor lateral support system has been significantly enhanced. Further tests are recommended to resolve still existing uncertainties. (auth)

5538 (WANL-TME-1023) RADIATION TEST OF A NERVA REACTOR CONTROL VANE SEGMENT (WANL TEST 15/W002). Zorn, J. B. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1964. 35p. Dep. NTIS $4.75.
Declassified 10 Sep 1973.
An irradiation test was conducted on a full size control vane segment to evaluate structural integrity in a radiation environment under the most severe load conditions and temperature expected during NERVA operation. Other factors evaluated during this experiment included: dimensional changes, specimen creep, hardness, density, weight loss, initiation of cracks or crumbling, metallography and burn-up of ^{10}B. Results of this test gave no significant evidence of radiation-induced effects which would represent potential problem areas with either the component design or the material of fabrication. Future tests should be conducted to obtain burn-up levels commensurate with the higher levels planned for NERVA. (auth)

5539 (WANL-TME-1030) STRESS ANALYSIS: PRELOAD SPRING ASSEMBLY AND DOME END SEAL. Henne, E. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1964. 37p. Dep. NTIS $5.00.
Declassified 10 Sep 1973.
All components were analyzed for the full-power, steady-state operating condition (100 per cent power, 100 per cent load), and their stresses were well within the specified yield point. A summary of the stress analysis for each individual component is given. (auth)

5540 (WANL-TME-1032) WIANCKO PRESSURE TRANSDUCERS. Qualification Test Report. Simoncini, M. V. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 13 Nov 1964. 51p. Dep. NTIS $5.75.
Declassified 10 Sep 1973.
Environmental tests and test results of Wiancko Engineering, variable reluctance, absolute and differential pressure transducers, Model No. 54726 and 54727 are described. The purpose of these tests was to obtain operational data on diagnostic pressure transducers in a high radiation environment, at cryogenic and elevated temperatures and under vibration. The temperature tests indicate the Wiancko Models 54726 and 54727 pressure transducers operate satisfactorily at temperature levels within the specified limits. Also, the transducers operate satisfactorily while being subjected to thermal shock as will be experienced in NRX tests. These tests do not clearly answer the questions raised, when the coil is at temperatures reaching 750°F and the case is at –320°F. These questions will have to be answered in radiation tests with cryogenic cooling. Tests conducted by Wiancko and reported in Wiancko Qualification Test Report show zero and sensitivity shifts due to temperature exposures of 750°F. The vibration tests conducted show the Wiancko pressure transducers Model 54726 and 54727 are not sensitive to vibration up to 25 g's. The vibration-induced error during NRX tests should be negligible. Other tests conducted by Wiancko include acoustic noise, time constant, acceleration, humidity, and mechanical shock tests. Acceptance tests conducted at WANL are reported in WANL-TME-872. (auth)

5541 (WANL-TME-1043) NRX-A REVIEW. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 4 Dec 1964. 112p. Dep. NTIS $8.75.

Declassified 11 Sep 1973.

The NRX-A review was mainly concerned with the status of NRX-A3, A4 and A5, in particular the degree of completion and schedule of major components. Attention was given to fuel element corrosion, coatings, pin holes, tests of fuel elements heated in reactors in capsules, etc. Instrumentation was reviewed, along with flow conditions (including leaks) in the test articles. (LTN)

5542 (WANL-TME-1050(Suppl.1)) NRX-A3 TEST PREDICTION REPORT. Howarth, W. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1965. 67p. Dep. NTIS $6.50.

Declassified 11 Sep 1973.

This supplement contains revised and/or added NRX-A3 test prediction information which supersedes the information in WANL-TME-1050 in the following areas: Ambient Gas Test–Revised profiles and added test predictions for ambient nitrogen; Dome End Pulse Cooling Test–Added test predictions; Liquid Hydrogen Flow Test–Revised test predictions; Power Test–Revised steady state operating points and added 15 minutes full power cooldown predictions, restart cooldown predictions and lateral support graphite temperature predictions; Steady State Mapping Test–Added test predictions; and Neutronic System Calibration Test–Added K factors. The test predictions are based on NRX-A2 test data and the latest Aerojet U-tube, S/N-22, nozzle data. (auth)

5543 (WANL-TME-1050(Supp. 2)) NRX-A3 TEST PREDICTION REPORT. Howarth, W. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1965. 29p. Dep. NTIS $4.50.

Declassified 11 Sep 1973.

5544 (WANL-TME-1053) PAX CRITICAL EXPERIMENTS IN SUPPORT OF NRX-A3. Freidhof, W. E.; Rankin, W. D.; Barksdale, C. E.; Kovacik, W. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1965. 91p. Dep. NTIS $7.75.

Declassified 11 Sep 1973.

Reactivity differences between the PAX and PAXA mockups were quite small. Similarly, fuel elements clusters manufactured by different fabricators differed only slightly in reactivity when similar groups were substituted in succession in critical mockups. Measurements of material worths were made for poison wires, uranium, beryllium, etc. The radial flux distribution at the core periphery showed a significant dependence on the critical drum bank angle. (LTN)

5545 (WANL-TME-1059) A-11 SEVEN CLUSTER MODEL: FFL-10 SOLID CORE TESTS. Cherish, P.; Leff, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Dec 1964. 112p. Dep. NTIS $8.75.

Declassified 11 Sep 1973.

In earlier tests of the A-11 Seven Cluster Model, B-3 Single Seal High Pressure Isothermal Tests, and G-3 Plugged Core Flow Tests, good comparison of analytical experimental data obtained on lateral support and seal system flow rates was dependent upon the use of leakage flow area contributed by radial stepping of the filler strips and sealing surfaces. In order to predict the lateral support and seal system flow rates of the NRX-A reactor with a higher degree of confidence, additional testing was required. In addition to reducing the uncertainty in the flow rates, other information was desired on the effect of plunger pin leakage and of a variable area in the filler strip gap. The reasons for obtaining additional data in these three areas are given. The experimental results obtained from the solid core tests were found to be reasonable and within the expected accuracy of the measured test data. The results obtained with the seven cluster rig, used throughout the A-11 test program, proved to be very useful for providing vibration and lateral support and seal pressure distribution data to be used in the analysis of the NRX-A reactors. (auth)

5546 (WANL-TME-1068) REACTOR DESIGN AND DEVELOPMENT PROGRAM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Dec 1964. 24p. Dep. NTIS $4.25.

Declassified 11 Sep 1973.

The hot tests on the KIWI reactors and on the NRX-A2 together with the component tests have identified the major areas requiring substantially design improvements in the NRX-A2 reactor in order to achieve a reactor capable of operating at one hour or more full power. The required design and analysis effort must be supported by an adequate component test program. A parallel development program is required to produce an improved fuel, to select and demonstrate the capability of non-fuel materials, to develop a reactor control system and to develop adequate in-core instrumentation. Corrosion effects in the peripheral and interstitial core regions, the support block-fuel element interfaces, and in-core instrumentation central element corrosion are identified as the major problem areas in NRX requiring substantial improvement to obtain a reliable reactor capable of operating for more than one hour. Additional problems probably will be identified by future reactor runs and component tests. However, it is felt the above are the major problems. There are design changes which would improve the reactor or reduce its cost, but not necessarily increase its lifetime. For example: the interfaces between the reactor, pressure vessel and nozzle should be simplified. The reactor should be designed so that disassembly after a hot run is simplified. It would be desirable to re-use major components. (auth)

5547 (WANL-TME-1069) REPORT ON COMPUTER STUDIES OF PROPOSED NRX-A4 HIGH TEMPERATURE THERMOCOUPLES. Teyssier, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1964. 28p. Dep. NTIS $4.50.

Declassified 11 Sep 1973.

5548 (WANL-TME-1114) NERVA II REACTOR PRESENTATION, LOS ALAMOS, FEBRUARY 19, 1965. Holman, R. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Mar 1965. 66p. Dep. NTIS $6.50.

Declassified 10 Sep 1973.

Slides shown at a NERVA presentation at Los Alamos, Feb. 19, 1965 have been documented. Considerable information was presented on temperature limits of reactor components, design, corrosion, coupling for a two core array, radiation doses, etc. (LTN)

5549 (WANL-TME-1115) NRX-A SHIELD SEAL ANALYSIS. Buzza, C. V.; Stancampiano, P. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1965. 27p. Dep. NTIS $4.50.

Declassified 10 Sep 1973.

In the NRX-A Reactors, the seal between the core support plate and the shield prevents propellant exiting from the reflector system from bypassing the shield and entering directly into the core. This seal consists essentially of a thin shell of revolution subjected to axial and radial sealing forces and a pressure differential. The stresses and sealing performance were analyzed for assembly, cooldown and steady state full power conditions. In all cases, the peak stresses are within the allowable stress of the seal material. In order to have a complete seal, the hold down springs must be sufficient to prevent binding of the seal ring, i.e., they must seat the seal ring flange against the core flow screen flange for relative axial movement between the shield and core support plate. The analysis indicates that this may not always be achieved. At design pressure differentials across the seal, it is probable that some leakage will occur at the flow screen flange interface depending on the tolerance combination of the various components and the tendency for relative axial motion. However, should axial separation between the seal ring flange and screen flange occur, the seal will still impede most of the flow from short circuiting the shield. (auth)

5550 (WANL-TME-1160) APPLICATION OF GAS TRACER TECHNIQUES TO THE DEFINITION OF REACTOR LEAKAGE FLOW LINES. Salvador, L. A.; Schulman, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 178p. Dep. NTIS $12.00.

Declassified 11 Sep 1973.

The feasibility of the gas tracer technique in defining flow directions through a complicated medium such as a reactor is demonstrated and test parameters are defined. Results of nineteen flow tests are presented in which, under steady-state hydrogen flow through the reactor at 300 psia, methane was injected through various interelement probes and sampled downstream of the injectors through other probes. Plots of methane concentrations from these samples versus reactor location are presented. They indicate a generally well-defined radial location of the tracer gas stream centerline at each axial core station. These centerline positions, when plotted against axial station, show flow directions along the core at the four radii at which injection probes were available. The resulting flowlines are reported and show a generally axial direction at the centerline and 13.5-inch radius but show a multiplicity of flow paths at the 7.5-inch radius. Inflow is indicated by flow lines near the core periphery. Initial efforts to correlate flow line maps with pressure maps are reported with an indication of general agreement between the two. (auth)

5551 (WANL-TME-1322) TEM-1: VOLUMETRIC ANALYSIS. Persin, W. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1965. 43p. Dep. NTIS $5.25.

A volumetric analysis of the thermoelectric module (TEM-1) is performed to determine how the material volume enclosed by the inner and outer cladding changes during swaging; also to determine whether or not volume interference exists between the claddings and the material contained by the claddings after the sintering process at room temperature and at operation. A 0.64% volumetric interference was found to exist at room temperature after sintering and an additional 0.95% during operation conditions. Considering the flexibility of the claddings and the compressibility of the lead telluride, these interferences imply internal hydrostatic pressures of 7500 psi at room temperature after sintering, and an additional 5500 to 8000 psi at operation. The 7500 psi pressure is about the point at which the outer clad, begins to yield at room temperature. The additional interference volume realized at operating conditions does not significantly alter this pressure because the outer clad's reduced yield strength at elevated temperatures is offset by strain hardening effects which essentially maintains a constant stress condition. (auth)

5552 (WANL-TME-1344) FUEL ELEMENT BORE WEIGHT LOSS CODE AND ITS APPLICATION TO THE NERVA CORE DESIGN. Davidson, S. L.; Richard, P. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1966. 65p. Dep. NTIS $6.25.

Declassified 11 Sep 1973.

A fuel element bore weight loss computer code has been developed to describe bore corrosion and its application to the NERVA core design. Reported are the two major modes of bore corrosion, mid-band and hot end, and their implication to the thermal and nuclear design. Included are the equations used for the calculation of bore corrosion and the methods by which these equations are utilized for both design and reactor test problems. Application of the weight loss code is shown in predicting weight losses and drum angle positions over the reactor operating map. Comparisons of measured and calculated weight losses are made with test observations. The major conclusion that may be drawn from this work is that the fuel element bore weight loss code provides a useful analytical tool for predicting fuel element bore weight losses and drum angle changes. (auth)

5553 (WANL-TME-1416) NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING HELD WITH SNPO AT WANL ON MARCH 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1966. 45p. Dep. NTIS $5.25.

Declassified 10 Sep 1973.

Results of miscellaneous tests performed on NRX-A5 and NRX-A6 reactor components are reviewed. (LTN)

5554 (WANL-TME-1506) REVIEW OF NERVA FLIGHT SAFETY SOURCE TERM INFORMATION. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Sep 1966. 225p. Dep. NTIS $14.25.

Declassified 10 Sep 1973.

The NERVA Source Term Program is part of the overall ROVER Flight Safety Program. This latter program has as its purpose the evaluation of the potential radiological safety problems arising from an in-flight abort of a nuclear-propelled rocket vehicle and the development of safety countermeasures which will be effective in minimizing these problems. A number of governmental agencies and industrial organizations have participated in the ROVER safety studies. The Source Term Program is concerned with the correlation of the information pertaining to the radiological safety problems resulting from re-entry and earth impaction of radioactive materials generated during flight operations of NERVA-type nuclear rocket engines. Such information encompasses the following topic areas: accident models and flight failure probabilities of nuclear powered rocket vehicles, the amount and distribution of radioactive debris on the Earth's surface in the event of an in-flight failure, evaluation of flight safety countermeasure systems, interactions of radioactive debris with man and evaluation of the resulting radiological effects, and probable radiation exposure of the world population resulting from nuclear rocket flight operations. Term reports summarizing this information have been periodically issued. The NERVA source term studies and flight safety work performed in the period from September 1964 to September 1966 are summarized. (auth)

5555 (WANL-TME-1510) ETS-1 NUCLEAR SUBSYSTEM COOLDOWN ANALYSIS. Pierce, B. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1966. 37p. Dep. NTIS $5.00.

Declassified 10 Sep 1973.

Cooldown data that satisfy the XE-1 and XE-2 Nuclear Subsystem (NSS) cooldown restraints are provided and preferred reactor cooldown modes recommended. A parametric study has been made that defines the NSS coolant fluid flow and pressure requirements as reflected at the nozzle torus. These data can be used to define the best coolant usage consistent with the facility. (auth)

5556 (WANL-TME-1519) WANEF CRITICAL EXPERIMENTS IN SUPPORT OF NERVA. Quarterly Report, 4th Quarter CY'66. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1966. 229p. Dep. NTIS $14.50.

Declassified 10 Sep 1973.

The nuclear facility activities support present and future reactor designs in addition to developing techniques in gamma and neutron spectrum analysis directly applicable to the NERVA contract. The PAX-E reactor contains a 90 degree mockup sector of the NRX-A6. The remaining 270 degrees, although not as good a mockup of A6, contain the masses and distribution of fuel and reflector constituents present in the NRX-A6 as presently defined. Specific experiments performed include the initial approach to criticality, drum worths, power distributions, reactivity coefficients, NRX-A6 detector response in its moderator environment, inreactor spectral studies, leakage flux measurements utilizing a Bragg-Gray detector system and fast neutron spectrometer, and detector material self-shielding studies. Additional experiments included power distributions and single drum withdrawal experiments in support of the XE-1 reactor and programming of the reactivity computer for use in conjunction with operations. Spectral data obtained in the 30 degree NRX-A6 mockup sector of the PAX-D assembly are also reported, as is spectral data obtained in the FCX reactor. WANEF effort in non-operational activities includes the continued updating of facility documentation and studies of source calibration of neutronics detectors for NTO. The major portion of these data will be used by the Thermal and Nuclear Design groups in determining shimming and orificing data as applied to the XE-1 and NRX-A6 reactors. (auth)

5557 (WANL-TME-1521) POST-OPERATIONAL EXAMINATION OF NRX-EST FUEL ELEMENTS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1967. 240p. Dep. NTIS $15.00.

Declassified 10 Sep 1973.

NRX-A4, the third reactor in the NERVA series tested at full power conditions, was successfully tested at Test Cell A, NRDS during the period of December 8, 1965 through March 25, 1966. The fuel elements operated at full design power levels and temperatures for approximately 30 minutes, almost twice that achieved in NRX-A3. Significantly it was the first NRX-A reactor to be restarted and operated by means of associated engine system components. Following the tests, the reactor was disassembled in the R-MAD facility at NRDS and its components examined. The results of all fuel element examinations are summarized. (auth)

5558 (WANL-TME-1532) JOINT WANL/LASL/Y-12 FUEL AND REACTOR DEVELOPMENT REVIEW, WANL, OCTOBER 11–12, 1966. Morris, W. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1966. 148p. Dep. NTIS $10.50.

Declassified 10 Sep 1973.

The review was concerned mainly with fuel elements (testing, corrosion, coatings, etc.) but also with some other results of NRX-A3, A4 and A5 tests. (LTN)

5559 (WANL-TME-1567) FRICTION AND WEAR TESTS OF NRX-A6 CORE PERIPHERY COMPONENTS. Morgan, L. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 16p. Dep. NTIS $4.00.

Declassified 10 Sep 1973.

Specimens of NRX-A6 core periphery components were tested to determine the friction forces and wear that would occur during reactor assembly and 5 reactor test runs of 10 minute duration each. The specimens were subjected to 5 simultaneous temperature and motion cycles that simulated reactor startup, operation, and shutdown conditions. The tests were performed in hydrogen at temperatures from 530°R to 4500°R and contact pressures from 10 psi to 150 psi. The measured static coefficients of friction were between 0.05 and 0.21 for the following interfaces: pyrofoil on uncoated filler strip, uncoated unfueled partial element on uncoated filler strip, pyrofoil on pyrotile, ZTA graphite on uncoated filler strip, ZTA graphite on pyrotile and ZTA graphite on ZTA graphite. Interfaces, where one surface is coated with niobium carbide, have higher friction and breakaway forces ranging from 0.18 to 2.2. Wear of contact surfaces of the test specimens was not significant except when pyrofoil was slid on niobium carbide coated filler strip. Delamination of the pyrofoil surface occurred after only one test cycle that simulated reactor test operation. Core periphery component specimens were also tested in a mixture of hydrogen and methane gas to determine breakaway and friction force that would result from use of a proposed methane

injection system. The breakaway and friction forces were determined to be as much as 25 times higher than corresponding values determined from tests performed in hydrogen. (auth)

5560 (WANL-TME-1580) NOTES OF MONTHLY DEVELOPMENT TEST PROGRAM REVIEW MEETING HELD WITH SNPO AT WANL ON MARCH 2, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 17 Mar 1967. 47p. Dep. NTIS $5.50.

Declassified 10 Sep 1973.

The review meeting was concerned mostly with the fabrication and testing of fuel elements, small graphite components and various seals, supports, etc. The dependence of the permeability of fuel elements to hydrogen and helium flow on temperature was investigated. The properties of pyrofoil wrapper material were studied. (LTN)

5561 (WANL-TME-1581) NRX-A5 POST-OPERATIVE MECHANICAL COMPONENT EVALUATION. Saccocio, R. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1967. 154p. Dep. NTIS $10.75.

Declassified 10 Sep 1973.

Upon completion of the NRX-A5 power tests, the reactor was disassembled and given a post-operative mechanical evaluation. Primary objective of the evaluation was to determine the design adequacy of the reactor components as verified by the post-test condition of the components. The evaluation showed that the reactor was in excellent condition; however, the results indicated the need for further development in the areas of fuel element corrosion resistance and hot buffer periphery design. The modification made to the control drums was successful in eliminating the drum bow experienced in the past. The severe flaring of the aft end of the liner tubes, which actually split one of the tubes into a petal-like pattern in NRX-EST, did not recur on NRX-A5. Some of the liner tubes, however, exhibited a slight flaring condition, indicating the need for some reduction in their length. The coated ATJ support washers were in excellent condition: the coating was intact; and corrosion, as experienced in NRX-EST, was not observed. Reactor instrumentation performed in an excellent manner throughout reactor operation. Visual examination showed all instruments to be in good condition. The remainder of the reactor components were generally in excellent condition, with few or no anomalies. (auth)

5562 (WANL-TME-1587) WANEF CRITICAL EXPERIMENTS IN SUPPORT OF NERVA. Quarterly Report, 1st Quarter CY'67. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1967. 49p. Dep. NTIS $5.50.

Declassified 10 Sep 1973.

Work on criticality mockups in support of the NRX-A6 and XE-PRIME reactors is reported. Reactivity worth measurements were made as a function of radial position for molybdenum, uranium, carbon, tantalum, beryllium and graphite. Numerous other dosimetry and reactivity measurements were made. Fuel element shipping containers of stainless steel with 1 percent boron were examined. They reduced neutron count by a factor of six. The development of detection systems for radiation measurements in and around the NERVA core is in progress. (LTN)

5563 (WANL-TME-1727) MODEL STATUS REPORT, 1967. Saluja, J. K.; Secker, P. A.; Buker, J. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1968. 48p. Dep. NTIS $5.50.

Declassified 10 Sep 1973.

A discussion of the results of computer studies made during 1967 with models more rigorous than the Common Analog Model (CAM) is presented. These studies were made as part of a continuing effort to provide the simplest and most accurate CAM models for use in systems and control studies and to lay the foundation for a more rigorous digital systems dynamic model for use in verifying the adequacy of the simpler CAM models. Previous reports have documented the basic Common Analog Models used for official test predictions of the NRX/EST and NRX systems. A discussion is presented of a study of the dynamic effects of the inclusion of more complex equations and more detailed hydrogen property simulations in the reflector. Similar studies with the shield and reactor core have yet to be done. Also, a discussion of the results obtained with a more complex support element simulation is presented. Comparisons of these more rigorous models with the CAM are given, and conclusions which can be drawn from these comparisons presented. A detailed description is also presented of various modeling techniques developed and used in the studies. (auth)

5564 (WANL-TME-1798(Vol.6)) VOLUME VI. Summary and Recommendations. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 26 Jun 1968. 79p. Dep. NTIS $7.00.

Declassified 11 Sep 1973.

This volume, entitled Summary and Recommendations, is one of seven volumes prepared to support the planned Engineering Data and Design Concepts Meeting on NERVA 1. It includes a summary of recommendations; and for each Engineering Critical Component (ECC), a listing of the candidate designs, a Comparison Matrix of Design Approaches, and the Recommended Design Approach (or approaches) for that Engineering Critical Component of the nuclear reactor. These recommendations should permit completion of the NERVA 1 reactor design most expeditiously and with the highest probability of meeting the program requirements. (auth)

5565 (WANL-TME-1806) NRX-A6 POST-TEST DYNAMIC ANALYSIS. Milton, J. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 144p. Dep. NTIS $10.25.

Declassified 11 Sep 1973.

The NRX-A6 post-test dynamic analysis to evaluate the Common Analog Model (CAM) simulation of the Test Cell "C" feedsystem, emergency shutdown system, and the reactor was performed on both the WANL analog computer and CDC-6600 digital computer. The changes made to the CAM-A6 equations as a result of comparisons of these runs with test data are described. Areas in which further model improvement is indicated are discussed. In general, agreement of the CAM simulation with test data is good except in certain areas which are noted. (auth)

5566 (WANL-TME-1811) SUMMARY OF WESTINGHOUSE ASTRONUCLEAR LABORATORY RAW MATERIALS ACTIVITIES FOR NERVA APPLICATION. Fatzer, E. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1968. 143p. Dep. NTIS $10.25.

Declassified 11 Sep 1973.

The Westinghouse Astronuclear Laboratory procures production quantities of raw materials for NERVA reactor fuel elements in accord with the WANL-TNR-088 interpretation of the requirements specified in NASA NPC 200-2. Extensive qualification of raw materials is performed in NERVA processes to assure conformance with these specifications. Continuing programs are necessary to provide evaluation of raw material interactions with fuel element performance, specification upgrading, supplier qualification, and supplier process control. The present status of Purchasing Department Specifications used for raw material procurement is summarized. The specifications are included in Appendix C. The experience and skills available within NERVA Fuel and Materials, Product Assurance, Corporate Purchasing Departments, and the Corporate Specification and Controls Activities are utilized to insure a comprehensive raw materials procurement program at the Astronuclear Laboratory. The result is a positive program of maintaining inclusive bidders' lists, qualification of suppliers, and assured control of incoming raw materials. (auth)

5567 (WANL-TME-1816) EXPERIMENT DESIGN FOR GTR-20 RADIATION EFFECTS TEST OF COPPER-BORON-10, 37/W409. Burwell, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jul 1968. 31p. Dep. NTIS $4.75.

Declassified 11 Sep 1973.

A radiation effects test of copper-boron 10 control vanes is planned in the GTR reactor. This is a new material not previously used in reactors and the radiation effects on the mechanical properties are required. Fast neutron fluences of 5×10^{18} nvt have been chosen. (LTN)

5568 (WANL-TME-1817) EXPERIMENT DESIGN FOR GTR-20 RADIATION EFFECTS TEST OF INCONEL-718, 37/W410, 15/W101, and 15/W202. Burwell, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jul 1968. 41p. Dep. NTIS $5.25.

Declassified 11 Sep 1973.

A radiation effects test of 4 alloys used in critical NERVA components (support stems, support springs, etc.) is planned to determine if there are any limitations, such as loss of ductility, stress relaxation, etc. which develop as a result of reactor irradiation and high or cryogenic temperatures. Fast neutron fluences greater than 10^{19} nvt are planned. (LTN)

5569 (WANL-TME-1818) EXPERIMENT DESIGN FOR GTR-20 RADIATION EFFECTS TEST OF SHIELD MATERIAL, 37*W411. Burwell, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jul 1968. 44p. Dep. NTIS $5.25.

Declassified 11 Sep 1973.

A radiation effects test of a new shield material (a mixture of aluminum, titanium hydride and boron carbide (B_4C) extruded at

high pressure) is planned for the GTR reactor. A fast neutron fluence of up to 5×10^{18} nvt is planned and after the test the mechanical properties are to be measured. (LTN)

5570 (WANL-TME-1819) EXPERIMENT DESIGN FOR GTR-20 RADIATION EFFECTS TEST OF SPOT WELDED TITANIUM BANDS, 15/W003. Burwell, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jul 1968. 17p. Dep. NTIS $4.00.

Declassified 11 Sep 1973.

A radiation effects test is planned in the GTR reactor for spot-welded titanium bands, which will be used in the control drum ganged drive system. A fast neutron fluence of up to 5×10^{18} nvt is planned. (LTN)

5571 (WANL-TME-1878) WESTINGHOUSE ASTRONUCLEAR LABORATORY CONTRIBUTION TO THE TWENTY-SEVENTH HIGH TEMPERATURE FUELS COMMITTEE MEETING, 10–12 DECEMBER 1968. Fleischer, L. R.; Simmons, C. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1968. 36p. Dep. NTIS $5.00.

Declassified 11 Sep 1973.

The fuel element performance in NRX-A6, which was tested at power for more than 1 hour, was much more successful than that in previous reactors. The fuel element corrosion was only 20 to 25 percent of that observed previously. Post test analysis showed that high thermal stresses had caused notch-type corrosion in some regions. This probably occurred during startup. Some fuel element, fuel particle, and coatings studies are reviewed. (LTN)

5572 (WANL-TME-1939) MICROSTRUCTURE OF NbC COATING. Kochka, E. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Jul 1969. 47p. Dep. NTIS $5.50.

Declassified 12 Sep 1973.

Prior to the Pewee I reactor, all fuel elements were NbC coated by a diffusion-controlled process. The rate of coating deposition is controlled by the rate of carbon diffusion from the matrix to the outer surface of the deposited coating. The rate of carbon diffusion through the coating is a function of temperature and coating thickness. Temperatures in excess of 1600°C are required to deposit two or more mils of NbC on graphite at a reasonable rate by a diffusion-controlled process. Diffusion coatings have two characteristics that adversely affect the corrosion test performance of an element. These are the loss of adherence that results from supplying carbon from the matrix, and the large cracks present in element areas operating below deposition temperatures that result from differences in the coefficients of expansion of the coating and matrix. Another process, the methane coating process, supplies carbon from the gas stream to form a coating that is deposited from 1000 to 1300°C. This coating is well-rooted in the matrix and has a much finer crack structure than a diffusion coating of equivalent thickness. However, this process is more sensitive to changes in gas composition and coating temperature than the diffusion process, and these changes are apparent in the different coating structures they produce. The development of NbC coating is traced through differences in coating structures based on parameter changes. (auth)

5573 (WANL-TME-1989) PERFORMANCE OF XE PRIME FUEL ELEMENTS. Simmons, C. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1970. 220p. Dep. NTIS $14.00.

Declassified 10 Sep 1973.

The results of limited postoperational examinations and analyses performed on XE Prime fuel elements are reported. Fuel performance was generally good with moderate weight losses, low pinhole densities, light surface corrosion, no interelement bonding, and very little corrosion weakening. Weight losses and bore corrosion in the hot end region were somewhat higher than predicted with losses, bore corrosion, and pinhole densities tending to be highest in Y-12 bore coated elements. Bore corrosion was predominantly by ring corrosion with some corrosion pocket formation indicating influence of cyclic and low power testing. Some minimal hydrolysis damage could have occurred in the Y-12 bore coated elements. Mild "notch" pattern corrosion occurred on some peripheral fuel elements. Element fracture due to corrosion weakening occurred predominantly on peripheral elements with this type of corrosion. Some corrosion of the exit faces of fuel elements occurred due to "sticking" to support block faces. There was a general tendency for the niobium carbide back coats to be nonadherent after test. (auth)

5574 (WANL-TME-2670) NERVA CLUSTER HARDWARE CONCEPTS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1970. 254p. Dep. NTIS $15.75.

Declassified 10 Sep 1973.

A Trade Study of design concepts for the Cluster Hardware, a component of the NERVA Nuclear Subsystem (NSS) is presented. The purpose is to evaluate and select the most logical and reasonable approach for continued detail design and development of this component consistent with the programmatic and technical requirements for the 10 hour full flow cycle engine as defined in the NERVA Program Requirements Document. The functional and technical requirements are identified by the Systems Engineering, December 1969, draft issue of the component specification, EC 677558. The alternate design concepts evaluated are: Hot End Support Plate, Counterflow Tie Tube with Pedestals, Cooled Support Block, Mid-Station Support Plate, Semi-Cooled Tension Members, Cooled Bottom Support Plate, and Cold End Support. The evaluation and selection is based on the construction of a comparison matrix. Each alternate is evaluated against the requirements and the tentative selection is based on an objective approach which identifies the concept having the maximum likelihood of meeting the functional, technical and programmatic requirements. "Counterflow Tie Tubes with Pedestals" is the concept selected and recommended for continued detail design and development. The major factors leading to this selection are described. (auth)

5575 (WANL-TME-2689) EVALUATION OF THE WANL INTEGRATED NUCLEAR, RADIATION, AND SHIELDING STANDARD DESIGN METHOD (WISDM). Volume II. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1970. 67p. Dep. NTIS $6.50.

Declassified 10 Sep 1973.

The WANL Integrated Nuclear, Radiation and Shielding Standard Design Method (WISDM) used in nuclear and radiation design and analysis of the NERVA Nuclear Subsystem is described. An evaluation of the accuracy of the WISDM methods and techniques is made by comparison with experimental results. WISDM is an integral part of an overall Design Engineering Method which is being developed to automate the mechanical, thermal, structural, nuclear, and radiation analyses and design of the NERVA Nuclear Subsystem. Methods related to predictions in the following nuclear, radiation, and shielding analysis areas are discussed: Absolute reactivity (for component sizing or fuel loading), control drum worth, fission distribution (for fuel zoning or coolant allocation), material reactivity worth (for evaluation of the effect of nonnominal compositions or conditions), shield performance, radiation heating rates (for component cooling requirements), and radiation environment (for radiation damage). This report is separated into two volumes. Volume 1 describes the WISDM techniques, evaluates the accuracy of the techniques by comparison with applicable experimental data, and discusses areas requiring improvement. Detailed statistical evaluation of the comparison of experimental and calculated results is presented for the methods used in calculating control drum worth, fission distribution, shield performance, radiation heating rate, and radiation environment. Volume 2 describes the reactor systems evaluated by WISDM. (auth)

5576 (WANL-TME-2725) REACTOR COOLDOWN CRITERIA. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1971. 65p. Dep. NTIS $6.25.

Declassified 11 Sep 1975.

Using the tank pressure cooldown system evolved in Trade Study 703, performance calculations were made to update hot bleed results to the full flow engine; operating procedures, and instrumentation and controls requirements were defined. Other topics such as use of additional throttling valves, reactor temperature conditioning, thrust nulling, impulse controllability, and laminar flow instability were covered for two alternate valve arrangements. The study concluded that the reference design met all requirements, and used 3213 lbs. propellant at an average chamber temperature of 1533°R (5033 lbs. propellant at 1700°R including the shutdown ramp for a 10-minute burn). The valve options of two alternate designs were within ±10% in performance, but less desirable as shown in a Comparison Matrix. For a ±5% on the decay heat uncertainty, the reactor must be capable of producing a 1455°R average chamber temperature in cooldown to meet the impulse controllability and minimum specific impulse requirements of the engine. This study used as its model, the full flow cycle with the reference NSS model in existence during the period of November 1969 to March 1970. (auth)

5577 (WANL-TME-2747) XE-PRIME TEST DATA COMPARISON WITH THE NSS COMMON ANALOG MODEL. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1970. 72p. Dep. NTIS $6.75.

Declassified 11 Sep 1973.

The steady-state, transient, and frequency responses of the XE-Prime test data are compared with the NSS portion of the Common

Analog Model (CAM) on the WANL Time and Frequency Response (TAF) digital computer code. From the steady-state comparison, greater deviation is experienced at lower temperatures and pressures. At higher temperature and pressure conditions up to design, the agreement improved and was excellent at design conditions. This same trend was exhibited in the transient comparisons. The open loop frequency response comparison of CAM with test data was favorable for the design and intermediate chamber conditions. However, at the lower temperatures and pressures the quality of frequency response test data was poor due to non-linearities in the system and high level of noise interference. Because of system non-linearities and noise, the low power test data were not compared to NSS CAM data. (auth)

5578 (WANL-TME-2758) NUCLEAR ANALYSIS REPORT, NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1971. 446p. Dep. NTIS $22.50.

Declassified 11 Sep 1973.

The Nuclear Analysis of the NUCLEAR SUBSYSTEM (NSS) and its Engineering Critical Components (ECC) constitutes the primary source of all steady state and transient nuclear data. The detailed Nuclear Analysis consisted of the following: Support for the derivation and establishment of appropriate performance and design requirements for the NSS and its ECCs, and Establishment and substantiation of the appropriate parameters of the selected design. The following detailed information is given: Development of the absolute reactivity prediction for the NSS and appropriate reactivity compensation techniques to account for the uncertainty in reactivity; development of a multizoned fuel loading distribution; development of a corresponding power distribution; development of the control drum span; the effect of the ECCs upon absolute reactivity and the radial and axial power distributions; development of the cold-to-hot reactivity feedback models and the corresponding cold-to-hot power distribution models; the key environmental conditions for all operating and non-operating conditions; and development of the uncertainties in the analytical methods and procedure. A description of the PAX/R-1 critical assembly is included. Material reactivity coefficients, drum span, and radial and axial power distribution measurements for the PAX/R-1 assembly are presented with their corresponding predictions. (auth)

5579 (WANL-TME-2764) MASS PROPERTIES ANALYSIS REPORT, NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1971. 149p. Dep. NTIS $10.50.

Declassified 12 Sep 1973.

The weight, center-of-gravity, and mass moments of inertia for the NERVA Nuclear Subsystem and for its major components are described. The data are based on the configuration shown on WANL Drawing 939J740 and are prepared in support of the NSS Preliminary Design Review. (auth)

5580 (WANL-TMI-387) FRICTION BINDING OF SLIDING PARTS. Igne, E. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Nov 1962. 9p. Dep. NTIS $4.00.

From the analysis of "Friction Binding of Sliding Parts" it was found that if the coefficient of friction varies from .2 to .4, the maximum stresses in the neck of the lateral support block are 26.2 and 58 psi respectively for the bending stresses and about 9 and 4 psi respectively for the shear stresses. The longitudinal expansion required to develop the maximum load in the neck of the lateral support is .035 and .075 in. for a coefficient of friction .2 and .4 respectively. If the longitudinal expansion exceeds these values the core with respect to the lateral support block will slip. (auth)

5581 (WANL-TMI-626) DEFLECTION OF AN ALUMINUM SHEET INTO A DEPRESSION IN A GRAPHITE BLOCK. Schreiber, J. J.; Skoff, R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Apr 1963. 15p. Dep. NTIS $4.00.

A 6 × 6 in. sheet of 2219-T31 aluminum alloy was uniformly loaded while being supported by a similar size block of graphite with a diamond shaped cavity. The load was produced by a dry nitrogen gas pressure of 150 psig. Static tests were performed with the aluminum sheets at room and low temperatures (~-320°F). A single dynamic test was also performed at room temperature. (auth)

5582 (WANL-TMI-1435) BOUNDARY CONDITIONS IN TDC. DeBaryshe, P. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 9 Apr 1965. 4p. Dep. NTIS $4.00.

The proper boundary conditions in the TDC code for NERVA calculations are specified. (JWR)

5583 (WANL-TMI-1981) QUALIFICATION OF PRIMARY LOOP MANIFOLD OF A LIQUID METAL THERMOELECTRIC CONVERTER. Sinwell, J. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jun 1969. 8p. Dep. NTIS $4.00.

The results of a test to check and verify the integrity of the welded joints in the primary loop manifold assembly of a four-pack thermoelectric module are presented. (JWR)

5584 (WANL-TNR-002) SHIELDING AND RADIATION ANALYSIS, NERVA PHASE I ACTIVITY, NERVA NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 152p. Dep. NTIS $10.75.

Declassified 10 Sep 1973.

Shield nuclear and thermal design data, and radiation environment data generated during Phase I of the NERVA Contact are described. The shield nuclear analyses include definitions of the radiation environment around a shielded and unshielded core, propellant tank heating for the shielded and unshielded conditions, and a vehicle optimization study for determining the minimum weight of the vehicle system required to limit the propellant heating to an acceptable level. The thermal analyses were carried out for both the heated bleed and the hot bleed cycles. Various heat exchanger shield design configurations were investigated and are included in this report. (auth)

5585 (WANL-TNR-007) INTERFACE STUDIES, PHASE 1: NERVA NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 24p. Dep. NTIS $4.25.

Declassified 10 Sep 1973.

Interface studies between the nuclear and non-nuclear subsystems of the NERVA engine were undertaken in order to determine the interaction of these systems so that design efforts could be coordinated. The interface dividing line used was that of the inner surface of the pressure vessel. Two major considerations in this evaluation were: (a) the possible location and size of pressure vessel flanges, and (b) the relative advantage of a core separable from the beryllium reflector and supported on the nozzle, such that the core may be removed without the reflector, as opposed to a core and reflector built and installed as a unit. (auth)

5586 (WANL-TNR-008) REACTOR SHIELD DESIGN, PHASE 1: NERVA NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 43p. Dep. NTIS $5.25.

Declassified 10 Sep 1973.

The preliminary shield design presented will serve as the basis for future design effort. The primary function of the shield in the NERVA engine is to limit the radiation heating of the propellant in the vehicle tank to an acceptable level. In addition it provides a heat source for the turbine working fluid in the heated bleed cycle, and limits the radiation heating and activation of the engine components. The shield requirements are defined and, the preliminary shield design generated in the initial phase described. The structural analysis of the lithium hydride shield which satisfies the requirements is reported and the method of manufacture discussed. (auth)

5587 (WANL-TNR-012) NERVA NUCLEAR SUBSYSTEM. Phase I. Cantilever Bending Tests of KIWI B-1 Module. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 14p. Dep. NTIS $4.00.

Declassified 10 Sep 1973.

Cantilever tests were conducted on a module at room temperature to determine the effect of the gasket on the end deflection of a module under lateral loading. This effect must be considered if the modules of the B-1 Design are to be bundled together by a lateral support. The results are from cantilever tests on a module approximately 38 inches long. This data was modified for the actual 52-inch module. Data on the module deflection was obtained as influenced by the following: Effect of the gasket at the support plate, effect of a lockwasher at the support tube, effect of preload torque-down of the module support tube, effect of creep of the module and gasket, and effect of load or test history. (auth)

5588 (WANL-TNR-022) NERVA NUCLEAR SUBSYSTEM. Phase I. Reliability Program. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 56p. Dep. NTIS $6.00.

Declassified 10 Sep 1973.

Phase I work on the NERVA nuclear subsystem reliability program is described, especially the planning of the reliability and quality assurance program for the follow-on phases. The program planning effort is described very briefly and a separate report is referenced. Reliability analyses were made on the

following designs: KIWI B 1A Reactor, KIWI B4 Reactor, and the Bendix Actuator No. 2682-002-200. These analyses were a combination failure mode analysis and design review. The purpose was to highlight design modifications required in adapting these designs to a flight environment. These designs, which were made for experimental purposes and ground testing, did not meet flight environmental conditions well. The deficiencies have been examined for guidance in flight design and are not intended as criticisms of the designs examined. A discussion of the required modifications is presented for each design. In addition, a complete summary of all failure modes, along with their causes, and recommended corrective actions, are shown. A method of determining a complexity index for a design was developed. The need for such a method is apparent in the case of the reactor preliminary design due to lack of past experience on which to base reliability apportionments and decisions as to the most reliable design choices. The complexity index system is described and a typical complexity index determination is shown. (auth)

5589 (WANL-TNR-024) NERVA B-1 REACTOR, PHASE 1: NERVA NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsubrgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 87p. Dep. NTIS $7.50.

Declassified 10 Sep 1973.

Preliminary analysis on two NERVA B-1 designs has indicated their feasibility for a flight type reactor. Those components found unacceptable in the KIWI B-1 design due to NERVA requirements, have been redesigned. Various alternative redesigns of some of the NERVA B-1 components, such as other core lateral support schemes, remain to be examined with additional test data to evaluate further the merits of the NERVA B-1 reactor for a rocket propulsion system. (auth)

5590 (WANL-TNR-036) CONTROL DRUM ACTUATOR DEVELOPMENT. NERVA Nuclear Subsystem. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 55p. Dep. NTIS $5.75.

Declassified 10 Sep 1975.

NERVA control drum actuators are described. Three different types are compared, actuator problems are identified, research programs are described and actuator testing facilities are discussed briefly. (LTN)

5591 (WANL-TNR-100) PRELIMINARY NRX-A ASSEMBLY PROCEDURES, COLD ASSEMBLY AT WANL. Zwillich, A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1963. 138p. Dep. NTIS $10.00.

Declassified 10 Sep 1973.

5592 (WANL-TNR-111) ASSEMBLY PROCEDURES, PHASE I VIBRATION (CORE-INNER REFLECTOR). Zwillich, A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1963. 91p. Dep. NTIS $7.75.

Declassified 10 Sep 1973.

Assembly procedures for vibration testing the core and inner reflector of the NERVA reactor are defined. The equipment necessary is described and additional documents or supplementary information required are identified. (LTN)

5593 (WANL-TNR-162) INTERIM REPORT ON THE RELEASE OF FISSION PRODUCTS FROM NERVA FUEL. Rymer, G. R.; Grandy, G. L.; Henninger, W. A.; Roll, J. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Jul 1964. 58p. Dep. NTIS $6.00.

Declassified 10 Sep 1973.

The results of a series of experiments on the nature and extent of the release of fission products from Type II NERVA fuel are reported. The program began in the Fall of 1962 and included steady-state irradiations at the GETR, Vallecitos, California, transient irradiations at the TREAT reactor, Arco, Idaho, simulated re-entry conditions at Thermal Dynamics, Lebanon, New Hampshire, and diffusion path studies at the Westinghouse Waltz Mill facility. The threshold temperature for release of fission product nuclides from NERVA fuel was found to be 1500°C for periods of 30 minutes or less. The relative release rate of the nuclides studied, in decreasing order of activity, were: Sr^{89}, Ba^{140}, Ce^{144}, Y^{91}, Cs^{137}, I^{131}, Te^{129}, Ru^{103}, Zr^{95}, and Mo^{99}. It was determined that release fractions of most nuclides, as a function of time, could be represented empirically by means of two simple mathematical models. (auth)

5594 (WANL-TNR-199) ANALYSIS OF NRX-A2 REACTOR TEST RESULTS. Boman, L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1965. 416p. Dep. NTIS $24.00.

Declassified 12 Sep 1973.

The NRX-A2 reactor was tested at NRDS from 12 August 1964 to 15 October 1964. To determine operating conditions during the test and verify or upgrade analytical methods used in reactor thermal and nuclear design, an analysis of the test results was made. The test series consisted of experimental plans as follows: Initial criticality and control drum worth measurements; initial automatic startups and ambient GH_2 and liquid hydrogen flow tests; neutronics calibration and temperature coefficient test; scaled-down power test; high power test; and restart and low power mapping test. Maximum reactor operating conditions were 1096 MW reactor thermal power, 75.6 lb/sec LH_2 flow rate, and 3815°R average core exit gas temperature. Total energy generated during the high power test was 3.41×10^{11} watt-seconds or an average of 813 MW over the 7 minute test. Total energy generation for the test series was 3.81×10^{11} watt-seconds. The thermal and nuclear test results are analyzed. Dosimetry measurements are reported and analyzed. (auth)

5595 (WANL-TNR-199(Supp.2)) ANALYSIS OF NRX-A2 REACTOR TEST RESULTS. Capo, M. A.; Nassano, R. N.; Stephenson, L. D.; Romesburg, H. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1965. 83p. Dep. NTIS $7.25.

Declassified 12 Sep 1973.

The NRX-A2 test series was successfully carried out in Test Cell A at NRDS between 12 August 1964 and 15 October 1964. An evaluation of the thermal and nuclear characteristics and an initial evaluation of dosimetry results was given in WANL-TNR-199. Additional analyses of reactor flow distributions, core and lateral support temperatures, critical control drum positions and feedback reactivity were given in Supplement I. The previously presented analysis of the NRX-A2 dosimetry established that the techniques employed in the Standard Design Method predicted the gamma ray environment to within about 30 percent accuracy in regions where the preponderance of the dose rate results from direct radiation from the reactor. However under the privy roof and at test car locations where scattering and secondary sources outside the reactor are important and where the Standard Design Method is not directly applicable, there were significant differences between calculated and measured data. A re-evaluation of the radiation levels at these locations has been made in an attempt to resolve these differences. The results of this analysis are presented here for comparison with the experimental data. It was further indicated in reference 1 that there was a need for continued analysis of the neutron radiation environment which, in general, evidenced more severe disagreement between calculation and experiment than did the gamma data. Additional analyses, presented in this supplement, includes carbon and beryllium moments data calculations of fast neutron dose and spectra, calculation of fast neutron fluxes using angular leakage fluxes from transport theory calculations, and calculation of the azimuth variation in the thermal and epithermal neutron flux. Analysis of heating rate data obtained from calorimeter measurements and analysis of post operational gamma radiation levels in the test cell area have been completed since WANL-TNR-199 was published and are also presented. (auth)

5596 (WANL-TNR-207) NRX-A4 DESTRUCT TEST REPORT. Kilp, G. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Nov 1965. 72p. Dep. NTIS $6.75.

Declassified 12 Sep 1973.

The corrosion testing program for NRX-A4 fuel elements indicated that a substantial improvement in bore life capabilities and end performance has been achieved compared to previous elements. Hot end failures, short-time (10-20 min.) corrosion failures, and pinholing were minimal during the corrosion test program. As reactor full power life requirements increase, it is clear that mid-band corrosion problems will require further development attention. The behavior of the hot end external coating also must be improved. A number of promising remedial approaches are available; chief among these is the use of longer unfueled tips combined with extended external coating coverage. The principal approach adopted for NRX-A5 fuel elements for minimizing the problem of mid-band corrosion is to increase the NbC bore coating thickness in the mid-band area. This approach is expected to permit the development of 60 minute fuel elements with acceptable corrosion behavior. (auth)

5597 NUCLEAR SHIP PROPULSION DEVELOPMENT FORECASTS. Cavaggioni, M. (CNEN, Milan, Italy). Com. Naz. Energ. Nucl., Not.; 21: No. 1, 27-49(Jan 1975). (In Italian).

The research conducted and the projects completed or under way in the field of nuclear ship propulsion are described. Development forecasts are presented. (auth)

Reactor Safety and Environmental Aspects

Refer also to abstracts 3481, 3491, 3733, 3815, and 3826.

5598 (AI-AEC-13144) NUCLEAR SAFETY CHARACTERIZATION OF SODIUM FIRES AND FAST REACTOR FISSION PRODUCTS. Quarterly Technical Progress Report, October–December 1974. (Atomics International Div., Canoga Park, Calif. (USA)). 15 Feb 1975. Contract AT(04-3)-824. 15p. Dep. NTIS $4.00.

Progress is reported in the areas of sodium splash dispersal studies, program planning, computer code development, and HCDA source term scoping tests. (DG)

5599 (CENPD-107(Rev.01)(Suppl.1)) ATWS MODEL MODIFICATIONS TO CESEC. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Apr 1975. 31p. Combustion Engineering, Inc., Windsor, CT.

In the course of the analysis of a postulated ATWS event, the Nuclear Steam Supply System (NSSS) parameters may assume values such that neither the range of variation of the parameters nor the attending dynamic phenomena are appropriately modeled by the NSSS simulation code normally used for accident analysis. This report details the modifications necessary to extend the analytical capabilities of the CESEC (Combustion Engineering NSSS Digital Simulation Code) model in order to encompass the analytical requirements of treating ATWS incidents. (auth)

5600 (CENPD-132(Suppl. 1)) CALCULATIONAL METHODS FOR THE C-E LARGE BREAK LOCA EVALUATION MODEL. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Feb 1975. 130p. Combustion Engineering, Inc., Windsor, CT.

Additional descriptive material for the Combustion Engineering large break Loss-of-Coolant-Accident analysis methodology is presented. (JWR)

5601 (CONF-731218-P1, pp 37-51) RELEASE OF FISSION PRODUCTS FROM ZIRCALOY-CLAD UO_2 FUEL AT AROUND 1000°C. Hillary, J. J.; Taylor, J. C. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Fission product release experiments have been carried out with Zircaloy-clad UO_2 fuel pins including two which were available from an irradiation experiment in SGHWR. The pins were caused to fail in flowing steam at approximately 1000°C, conditions which are relevant to some SGHWR fault situations, and the escaped fission products Xe-133, I-131, and in some cases Kr-85, were trapped and measured. The results of the experiments are assessed with a view to providing the best present estimates of inert gas/I-131 release ratios for use in reactor accident evaluation. (auth)

5602 (COO-2471-2) MODELING OF CLADDING AND FUEL MOTION IN A LOSS OF FLOW SITUATION FOR GCFR SAFETY ANALYSIS. Progress Report 2, October 1, 1974–December 31, 1974. Eggen, D. T. (Northwestern Univ., Evanston, Ill. (USA). Technological Inst.). 15 Feb 1975. Contract AT(11-1)-2471. 22p. Dep. NTIS $4.25.

A model two-foot long 37-element fuel assembly was fabricated and a test was made to study the effects of falling molten metal into a simulated blanket region. The liquid was initially entrained in the upper grid spacer and some melt through was experienced. However most of the molten metal (50 Pb/50 Sn) bypassed the cluster and was lost from the test. Redesigning of the assembly enclosure will alleviate this problem. A new assembly has been fabricated and will be tested. (auth)

5603 (COO-2471-3) MODELING OF CLADDING AND FUEL MOTION IN A LOSS OF FLOW SITUATION FOR GCFR SAFETY ANALYSIS. Technical Progress Report (Annual), June 15, 1974–March 15, 1975. Eggen, D. T. (Northwestern Univ., Evanston, Ill. (USA). Technological Inst.). 1 Apr 1975. Contract AT(11-1)-2471. 12p. Dep. NTIS $4.00.

During the first nine months of the project, methods and apparatus were developed to study the freezeout of molten cladding in a cooler blanket region. Three tests were run in which a mass of molten material from a simulated core region of a GCFR flowed into a bundle of simulated blanket elements. In all cases plugging occurred in or before the first grid-spacer. Theories and preliminary models are in accord with these observations. These tests have been done with a 50/50-Pb/Sn alloy simulating the cladding and spacer grids and alumina simulating the fuel. Materials are being obtained for tests with stainless steel cladding and spacers. Development is progressing well on an electrically-heated fuel element which will be used to study the melting and motion of cladding in the core region for a loss of flow accident. Preliminary models are being developed to calculate the motion and freezeout of flowing cladding in the blanket region. The SAS-GAS and Argus codes are being adapted for uses in conjunction with model development on the project. A survey of fission gas effects in oxide during TOP cases was prepared and other codes (LIFE) were reviewed for possible value on the project. A set of reference physical parameters is being developed for the various materials used in the analysis and experiments. (auth)

5604 (CREARE-TN-202) HOT WALL EXPERIMENTS IN A SIMULATED MULTILOOP PWR GEOMETRY. Block, J. A.; Crowley, C. J. (Creare, Inc., Hanover, N. H. (USA)). Feb 1975. 48p. (COO-2485-1). Dep. NTIS $5.50.

Results are presented of an investigation of the effects of heated vessel and core walls on downcomer flow behavior in the absence of core or cold leg steam flows. Energy stored in these walls could interact with emergency core coolant (ECC) water during a postulated loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR) and delay the delivery of this water to the lower plenum. Several of the parameters which affect this process were explored experimentally in a 1/15-scale, planar model of a multiloop PWR downcomer. The variables which strongly affect the hot wall delay period were found to be: inlet water temperature, initial wall temperature, downcomer gap spacing, and downcomer length. For example, as the inlet water subcooling was decreased from 160°F to 0°F the hot wall delay time increased by an order of magnitude. The influence on the delay time of wall and water temperatures, downcomer dimensions, number of cold legs, and water flow rate is presented. Because the hot wall effect is not an off/on phenomenon, a number of representative lower plenum filling rate experimental traces are presented along with a technique for reconstructing other traces from the tabular data presented. A theory for the hot wall effect is presented and compared with the delay time and lower plenum filling rate data. (auth)

5605 (GA-A-12462) SORS: COMPUTER PROGRAMS FOR ANALYZING FISSION PRODUCT RELEASE FROM HTGR CORES DURING TRANSIENT TEMPERATURE EXCURSIONS. Duncan, D. S. (General Atomic Co., San Diego, Calif. (USA)). 28 Feb 1975. 84p. (GA-LTR-10). General Electric, San Diego, CA.

Additional information on the SORS computer code is presented. SORS analyzes fission product release from HTGR cores during transient temperature excursions. (JWR)

5606 (GA-A-13284) RELIABILITY MODEL FOR COMMON MODE FAILURES IN REDUNDANT SAFETY SYSTEMS. Fleming, K. N. (General Atomic Co., San Diego, Calif. (USA)). Dec 1974. Contract AT(04-3)-67. 8p. Dep. NTIS $4.00.

A method is presented for computing the reliability of redundant safety systems, considering both independent and common mode type failures. The model developed for the computation is a simple extension of classical reliability theory. The feasibility of the method is demonstrated with the use of an example. The probability of failure of a typical diesel-generator emergency power system is computed based on data obtained from U. S. diesel-generator operating experience. The results are compared with reliability predictions based on the assumption that all failures are independent. The comparison shows a significant increase in the probability of redundant system failure, when common failure modes are considered. (auth)

5607 (HEDL-SA-791) FAST FLUX TEST FACILITY SODIUM FIRE TESTING PROGRAM. Chandler, J. C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-2170. 6p. (CONF-750113-1). Dep. NTIS $4.00.

From nuclear engineering seminar; Richland, Washington, USA (11 Feb 1975).

5608 (HEDL-TME-74-4(Vol.3)) HEDL QUARTERLY TECHNICAL REPORT, OCTOBER–DECEMBER 1974. Volume 3. Reactor and Safety Engineering. Slember, R. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jan 1975. Contract AT(45-1)-2170. 48p. AT.

Core engineering tasks included core physics studies and radiation and shield analysis for FFTF. Safety analysis and engineering tasks included postaccident heat removal studies, code development, steam venting studies, cold liner analysis, and scaling up of HCDA scale model test results. (JWR)

5609 (KFK-EXT-28/74-1) RESULTS OF COMPARATIVE CALCULATIONS USING THE CODES BRUCH-D AND RELAP 3 FOR A LOSS-OF-COOLANT ACCIDENT OF A 1200 MW_e PWR. Kirsch, D.; Sengpiel, W.; Liesch, K. J.; Schuetzle, R. (Kernfor-

schungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorentwicklung). Sep 1974. 107p. (In German). (MRR-140; IKE-2-6). Dep. NTIS (US Sales Only) $8.50.

The Project Nuclear Safety (PNS) has suggested comparative calculations with the computer codes BRUCH-D and RELAP 3 which are used for fluid- and thermodynamic calculations of the primary coolant loop of PWRs during a LOCA. These comparisons have been performed for a reference reactor of 3540 MW(t). Assuming a double-ended break (2 F break), a cold-leg break between pump and pressure vessel has been investigated as well as a hog-leg break between upper plenum and steam generator. Short descriptions of the computer codes used and detailed results of the calculations performed are presented. The comparison yields results which agree fairly well qualitatively and, in most cases, quantitatively. Since the input data for the two codes used have largely been fitted to one another, the remaining small differences are caused, and can be explained, by differences in the physical models used. (auth)

5610 (LA-5893-MS) ^{131}I RELEASE FROM A HTGR DURING THE LOFC ACCIDENT. Foley, J. E. (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1975. Contract W-7405-eng-36. 11p. Dep. NTIS $4.00.

The time-dependent release of ^{131}I from both the core and the containment building of a high temperature gas-cooled (HTGR) reactor during the loss of forced coolant (LOFC) accident is studied. A simplified core release model is combined with a containment building release model so that the total amount of the isotope released to the environment can be calculated. The time-dependent release of ^{131}I from the core during the LOFC accident is primarily a function of the time-dependent core temperatures and the failed fuel release constants. The most important factor in calculating the amount of the isotope released to the environment is the total amount released into the containment building. (auth)

5611 (LIB/Trans-551) COMPARISON OF THEORETICAL AND EXPERIMENTAL RESULTS OF EMERGENCY COOLING TRIALS WITH A 4-ROD BUNDLE. Steinhoff, F. Dec 1974. Translated by K. E. Cecers from Reaktortagung, Deutches Atomforum e.V., Berlin, 2–5 April 1974. 5p. Dep. NTIS (US Sales Only) $4.00.

Blowdown trials for the evaluation of heat transfer figures during powerful transients were carried out at the Kraftwerkunion Company in an SWR experimental rig in the framework of the German Emergency Cooling Program. The reactor core was simulated by a bundle of four electrically heated fuel rods. It was a further aim of this set-up to check the already present computer programs with trial calculations experimentally and to calculate the local cooling agent conditions, because at the rig, pressure, mass movements (currents) and density could only be measured at a few significant points. (auth)

5612 (NP-20341) RADIOACTIVE EFFLUENTS FROM NUCLEAR POWER STATIONS IN THE COMMUNITY. Discharge Data: Radiological Aspects. (Commission of the European Communities, Luxembourg. Directorate for Health Protection). Apr 1974. 46p. Dep. NTIS (US Sales Only) $5.50.

A summary is presented of the activities of gaseous and liquid waste discharged in 1969, 1970, 1971, and 1972 from nuclear power stations in the Community of Six and those run by the Central Electricity Generating Board in Great Britain. The typical compositions of radionuclides in the noble gases discharged by the various power stations are given. In the case of liquid effluents, a listing of the radionuclides identified in 1972 is given together with a description of the methods of activity assessment used. The fraction of the maximum permissible concentration for drinking water reached in the receiving watercourse is listed as an annual average. On the basis of the discharges, maximum exposure around the sites is estimated and compared with the dose limits fixed by radiological protection standards and with the level of natural radioactivity. The ratio of activity discharged (noble gases, liquid effluents excluding tritium) to the energy produced is given for each power station. (auth)

5613 (ORNL-NSIC-116) INDEX TO NUCLEAR SAFETY. A Technical Progress Review by Chronology, Permuted Title, and Author. Vol. 11, No. 1 Through Vol. 15, No. 6. Cottrell, W. B.; Klein, A. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 74p. Dep. NTIS $6.75.

This issue of the Index to Nuclear Safety covers only articles included in Nuclear Safety, Vol. 11, No. 1, through Vol. 15, No. 6. This index is presented in three sections as follows: Chronological List of Articles by Volume; Permuted Title (KWIC) Index; and Author Index. (auth)

5614 (ORNL-NSIC-117) PROTECTION OF NUCLEAR POWER PLANTS AGAINST EXTERNAL DISASTERS. Cottrell, W. B. (Oak Ridge National Lab., Tenn. (USA)). Apr 1975. Contract W-7405-eng-26. 401p. Dep. NTIS $23.25.

A bibliography and a compilation of articles on the protection of nuclear power plants from external disasters are presented. The subject matter includes tornadoes and high winds, floods and high waves, earthquakes, plane crashes, sabotage and diversion, acts of war, and other disasters. The articles included in this compilation are primarily review articles on various topics selected from Nuclear Safety. Relevant AEC regulations, rulings, and regulatory guides are also included where appropriate. The bibliography with each section includes all recent literature on each topic, each with its own key-word, author, and permuted title index. In addition, a brief commentary serves as an introduction to the report as well as to place its varied contents in perspective. An overall index to all textural material is also provided. (auth)

5615 (SAND-75-0068) EXPERIMENTAL FAST REACTOR SAFETY RESEARCH PROGRAM (COMBINED) QUARTERLY REPORT, JULY–DECEMBER 1974. Coats, R. L. (ed.). (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1975. AT(29-1)-789. 79p. Dep. NTIS $7.00.

Research progress is reported for the following tasks: post-accident heat removal in core debris beds; prompt burst excursion experiment; and feasibility of high-performance fuel elements for the ACPR. (JWR)

5616 (TID/SNA-773) FLIGHT SAFETY CONTINGENCY ANALYSIS REPORT, S103-CP090290-F1. Volume III. Nuclear Subsystems Contingency Analysis. (Aerojet-General Corp., Sacramento, Calif. (USA); Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1971. 196p. Dep. NTIS $13.00.

A detailed analysis of possible modes of failure of NERVA reactor components, the identification of the problem and then the possible corrective action to be taken, is presented for reactor-powered vehicles on space missions. (LTN)

5617 (TRG-Report-2625(R/X)) AN EQUATION OF STATE FOR URANIUM DIOXIDE FOR FAST REACTOR CONTAINMENT STUDIES. Allan, J. W. S.; Hoskin, N. E.; Morris, E.; White, P. H. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Oct 1974. 16p. (CONF-741031-11; AWRE-44/91/46; CFR/SWP/P-(74)34). Dep. NTIS (US Sales Only) $4.00.

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

This report describes a form for a practical constitutive relation covering behavior from a shocked dense solid to heated liquid (although an explicit solid-liquid transition is not included) and also including the two-phase liquid-vapor co-existence region. Data are defined on a reference curve which includes the Hugoniot (defining the compressive behavior under shock loading from normal density), the zero pressure line between normal density and the boiling point, and the complete saturation curve. Along this reference curve values of several thermodynamic variables are listed for a standard set of values of specific volume. Thus, updating of the data is an extremely simple matter. The methods of extrapolating away from this reference curve are described and discussed. New experimental data obtained at Aldermaston for inclusion in this form of relation are also presented, together with a description of the experimental techniques used to obtain these data. (auth)

5618 (WANL-TNR-052) NERVA NUCLEAR SUBSYSTEM. Phase I. Flight Safety Studies. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 177p. Dep. NTIS $12.00.

Declassified 10 Sep 1973.

Considerations of the safety aspects of conducting orbital missions with a nuclear rocket are presented. These considerations include various aspects of reactor destruct, problems of determining required data on fission product release from NERVA fuel material, and the burnup of the reactor upon re-entry. This report comprises three (3) topical reports. WANL-TNR-038, transient reactor experiments on NERVA fuel material, is concerned with an experimental program to determine the feasibility of using a reactor transient to destroy the core of a nuclear rocket. In addition to this primary objective, the transient experiments provide information on the nature of the shutdown mechanism, a determination of fission product release during controlled reactor transients, and a study of reactions between NERVA fuel and water during a reactor transient. WANL-TNR-039, re-entry and burnup of reactor fragments, presents both a theoretical approach and experimental approach designed to establish the amount of particle burnup which can be expected during re-entry. WANL-TNR-

040, survey of fission product release from NERVA fuel material, considers the problem of fission product release from an intact core during a decay heat cycle. (auth)

5619 (WANL-TNR-099) SAFETY REPORT FOR THE WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1963. 344p. Dep. NTIS $20.25.

Declassified 10 Sep 1973.

The Hazards Summary Report for the performance of critical experiments in support of the NERVA program at the Westinghouse Astronuclear Experimental Facility (WANEF) is presented. It is shown that a combination of design and procedural safeguards limits the radiological consequences of a credible accident to values considerably less than those of the proposed AEC criteria for power reactor siting (TID-14844). The "Maximum Credible Accident" results in an energy release of 800 megawatt-seconds (2.8×10^{19} fissions) which is terminated on temperature coefficient feedback when the center of the reactor core reaches a temperature of 780°C. Experimental data on fission product release from beaded fuel indicate that the release under these conditions should be negligible, even for iodine and its precursors. (auth)

5620 (WANL-TNR-148(Rev. 1)) SAFETY ANALYSIS REPORT, NRX TESTING. Hemmerle, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1964. 340p. Dep. NTIS $20.00.

Declassified 10 Sep 1973.

A detailed analysis of safety and reactor safety at the NRDS NERVA test site is presented, including management organization, site description, meteorology, controls, facility description, safety, excursion analysis, possible accidents, fission product release, radiation doses, etc. (LTN)

5621 (WASH-1283(Rev. 1)) GUIDANCE ON QUALITY ASSURANCE REQUIREMENTS DURING DESIGN AND PROCUREMENT PHASE OF NUCLEAR POWER PLANTS. Revision 1. (USAEC, Washington, D. C.). 24 May 1974. 188p. Dep. NTIS $12.50.

Additional information on the establishment and execution of a quality assurance program for the design and procurement phase of nuclear power plants is presented. (JWR)

5622 (WCAP-7288) PWR FLECHT. Final Test Plan. Cermak, J.; Farman, R.; Kitzes, A.; Leyse, R.; Skreppen, H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). 31 Jan 1969. 57p. Dep. NTIS $6.00.

The objective of the proposed FLECHT test program is to investigate the behavior of a simulated pressurized water reactor core during the core recovery period which follows a loss-of-coolant accident. The test data will include sufficient information to establish the transient behavior of heat transfer coefficients throughout the test array. The following specific information will be obtained: Time-temperature behavior of the cladding; conditions which result in adequate core cooling; minimum flooding heights at various power densities; effectiveness of core coolant systems to prevent core damage; effect of pressure on emergency core cooling capability; effect of soluble poison on emergency core cooling capability; effect of cladding damage; and local pressure drop. (auth)

5623 (WCAP-8432(Vol.2)) ECCS HEAT TRANSFER EXPERIMENTS WITH UPPER HEAD INJECTION. Volume II, Heat Transfer Data Analysis and Correlation. McIntyre, B. A.; Vijuk, R. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Jan 1975. vp. Westinghouse Electric Corp., Pittsburgh.

A heat transfer correlation was developed, by modification of established heat transfer correlations, to predict the blowdown cooling heat transfer in a PWR during a large break LOCA for a plant equipped with upper head injection (UHI). Also from the test data and LOCTA calculations, a model was developed for the quenching of the heater rod clad as a function of fluid quality and clad temperature. These correlations, when applied to the UHI blowdown tests performed on the G-1 test facility, through the use of a modified version of the LOCTA Code, have been shown to provide a conservative heat transfer evaluation by predicting low heat transfer rates and high heater rod clad temperature response as compared with measurements during the blowdown transients. It is concluded that the heat transfer correlations described are appropriate for use in LOCA blowdown analyses of Westinghouse PWR plants with UHI. (auth)

5624 (WCAP-8472) WESTINGHOUSE ECCS EVALUATION MODEL: SUPPLEMENTARY INFORMATION. Bordelon, F. M.; Buterbaugh, T. L.; Johnson, W. J.; Yang, J. W.; Kelly, R. D.; Kopelic, S. D.; Massie, H. W. Jr.; Zordan, T. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). Jan 1975. vp. Westinghouse Electric Corp., Pittsburgh, PA 15230.

This report presents modifications and supplementary information to the Westinghouse (W) Emergency Core Cooling Systems (ECCS) evaluation model of August 4, 1974. (auth)

5625 (WCAP-8485) SAFETY RELATED RESEARCH AND DEVELOPMENT FOR WESTINGHOUSE PRESSURIZED WATER REACTORS PROGRAM SUMMARIES, FALL 1974. Davis, M. H.; Gangloff, W. C.; Hull, R. T.; Hochreiter, L.; Kubit, C. J.; Pfiefer, N.; Vijuk, R. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Mar 1974. 58p. Westinghouse Corp., Pittsburgh.

Program summaries are presented for the following study areas: (1) ice condenser containment, (2) fuel development for operation at high power densities, (3) full length emergency cooling heat transfer system effects tests (FLECHT-SET), (4) reactor vessel thermal shock, (5) delayed departure from nucleate boiling (DDNB) testing, (6) acoustical monitoring, (7) steam/water mixing tests, (8) process development for minimizing in-pile fuel densification, (9) 17 x 17 fuel assembly verification, and (10) reactor coolant pump tests. (DG)

5626 (XN-75-6) FLOW BLOCKAGE MODEL FOR LOCA ANALYSES. Collingham, R. E.; Jaech, J. L. (Exxon Nuclear Co., Richland, Wash. (USA)). 1 Apr 1975. 63p. Exxon Nuclear Co., Richland, WA.

A flow blockage model applicable in PWR's during loss-of-coolant analyses is presented. During a postulated loss-of-coolant accident the high temperature may weaken the clad sufficiently to cause it to bulge in response to the internal gas pressure being higher than the surrounding pressure. Mechanical property models are used in BULGEX (ENC clad deformation model) to predict the onset of rod cladding instability or bulging; however, these models cannot predict the extent of bulging. Experimental data are available for determining the probability and extent of bulging. Statistical models are developed for predicting the magnitude of flow blockages in reactor fuel assemblies. Parameters in these models are evaluated with experimental rod bulging data from single and multi-rod tests that simulated LOCA conditions. The statistical models utilize bulge strain data and may be used to evaluate the following effects on maximum planar flow area blockage fraction: Presence of guide tubes; deformation of rods which have not bulged; movement of rod centers; different bulging probabilities between rods; and axial bulging distribution. The experimental data has shown the clad stress at bulging to be the primary variable for flow blockage. (auth)

5627 (XN-75-21) XCOBRA-IIIC: A COMPUTER CODE TO DETERMINE THE DISTRIBUTION OF COOLANT DURING STEADY-STATE AND TRANSIENT CORE OPERATION. Galbraith, K. P.; Patten, T. W. (Exxon Nuclear Co., Richland, Wash. (USA)). 1 Apr 1975. 70p. Exxon Nuclear Co., Richland, WA.

The computer model, XCOBRA-IIIC, and the method of calculation of the core flow distribution during system blowdown are described. The XCOBRA-IIIC code provides both transient and steady-state calculation capabilities while including the effects of crossflow mixing between fuel assemblies. For the core flow distribution analysis, the core is nodalized such that each radial node represents no more than one fuel assembly, and each assembly is represented with multiple axial nodes. This degree of nodalization plus the modelling options available in the code provides calculational flexibility so that factors affecting the core flow distribution such as: Differences in assembly hydraulic resistance, localized flow blockage in assemblies other than the high powered (hot) assembly, and crossflow occurrences between the hot assembly and its neighbor assemblies can be evaluated. (auth)

5628 (XN-75-23) EXXON NUCLEAR FUEL HEATUP MODEL FOR PWR LOSS OF COOLANT ACCIDENTS. Steves, L. H. (Exxon Nuclear Co., Richland, Wash. (USA)). 31 Mar 1975. 27p. Exxon Nuclear Co., Richland, WA.

The Exxon Nuclear fuel heatup model for pressurized water reactor loss of coolant accidents consists of the analytical methodology, including computer codes, used to predict the fuel thermal transient which would result from a Loss of Coolant Accident (LOCA) due to a postulated pipe break in the primary coolant loop. The ENC fuel heatup model does not include the methodology used to predict the hydraulic transients following the pipe break, since those transients are established by the nuclear steam system design and operating parameters and are, in general, not significantly affected by fuel design parameters. Output from the separately-calculated blowdown and reflood analyses is used as input to the ENC fuel heatup model. (auth)

5629 (XN-75-24) RELAX: A REACTOR SYSTEM BLOWDOWN ANALYSIS COMPUTER PROGRAM. Pugh, R. A. (Exxon

Nuclear Co., Richland, Wash. (USA)). Mar 1975. 69p. Exxon Nuclear Co., Richland, WA.

RELAX is a light water reactor blowdown transient analysis computer program developed to give a calculational procedure which meets the requirements of Appendix K 10 CFR Part 50, during the blowdown portion of a Loss-of-Coolant Accident (LOCA). It is a modification of the RELAP4/MOD002 computer program. The scope of the modification limits the application of the program to the transient thermal-hydraulic response of a reactor system during the blowdown following a major pipe break. Other phases of the LOCA analysis, such as refill, reflood or rod heatup would require alternate programs meeting the Appendix K requirements. (auth)

5630 ENERGY AND THE ENVIRONMENT. Proceedings of the First Annual AIChE Southwestern Ohio Conference, Oxford, Ohio, October 25–26, 1973. Buonicore, A. J.; Rolinski, E. J.; Earley, D. E. (Eds.). Dayton, OH; American Institute of Chemical Engineers (1974). 266p. (CONF-7310101-).

Separate abstracts are included for 3 of the 56 papers presented. The conference papers discussed the following topics: energy policy and utilization; industrial waste disposal; advanced energy sources; industry and the law; air pollution control; water pollution control; industrial energy problems; energy conservation; and noise pollution. (DCC)

For abstracts of individual papers see: 4155, 4156, and 5400.

5631 STANDBY EMERGENCY POWER SYSTEMS. Part II. The Later Plants. Hagen, E. W. Nucl. Safety; 16: No. 2, 162–179 (1975).

The second part of a two-part article that reviews the standby emergency electric-power systems for commercial nuclear power plants is presented. Part I appeared in the 14(3) issue of Nuclear Safety and discussed these systems as they applied to the early plants; Part 2, the later plants, updates the design criteria and considerations set forth in Part I and offers some suggestions for improving reliability and availability for these systems. Today, even within the confines of a single large utility, the system designs vary because of the different architect-engineers involved with the various plants, plant characteristics vary from site to site, and even concepts change with time within a given design group. Some of the design problems and operating experiences for the follow-on plants are exemplified, quality-assurance procedures are mentioned, and some considerations concerning reliability, which has not changed significantly for the later plants, are discussed. Since high availability of the standby emergency electric-power systems appears to be the more attainable characteristic to strive for, some methods for achieving this are proffered. (auth)

5632 SELECTED SAFETY-RELATED OCCURRENCES REPORTED IN NOVEMBER AND DECEMBER 1974. Casto, W. R. Nucl. Safety; 16: No. 2, 232–234(1975).

Of the occurrences reported during November and December 1974, five are reviewed because of their uniqueness and/or general interest to reactor operations. At Dresden 2 and Quad Cities 2, cracks from internal stress-assisted corrosion were discovered. A main-steam-line isolation valve leaked intermittently at the La Crosse boiling-water reactor (BWR). Cover gas from the quench tank at Maine Yankee leaked into the containment during shutdown work. Peach Bottom 2 was depressurized twice by failure of safety relief valves. Somewhat less than 6000 gal of primary water leaked from the feedwater system at Quad Cities 2. (auth)

5633 RECENT OCCURRENCES AT NUCLEAR REACTORS AND THEIR CAUSES. Casto, A. R. Nucl. Safety; 16: No. 2, 235–242(1975).

The information on reactor occurrences tabulated came from reports abstracted for the Nuclear Safety Information Center at Oak Ridge National Laboratory in November and December 1974. A brief description of each incident is included, along with the reactor and facility (or institution) at which the incident occurred. The docket numbers and the dates of the reports are included where appropriate. (auth)

5634 GBR-4 PROTECTION SYSTEMS: FAILURES AND THEIR CONSEQUENCES. Burgsmueller, P.; Dekais, J. J.; Kraehe, A.; Pignatelli, R.; Vleider, G. (Gas Breeder Reactor Association, Brussels). Nucl. Safety; 16: No. 2, 150–162(1975).

In the GBR-4 design of a gas-cooled fast breeder reactor, emphasis is placed on using to advantage the single-phase character of the coolant. Specific features of the protective systems are fail-safe neutron absorption, permanently operating auxiliary supplies, and atmospheric-pressure cooling. A computer program that uses a point reactor model for heat transfer and neutron kinetics is used for transient analysis, and a steam-generator dynamics code is used to describe secondary side effects. Anticipated disturbances in operation are reactivity insertion, loss of supplies, and loss of coolant pressure. Failures in reactor protection systems are postulated for these disturbances in decreasing order of probability, and the consequences are analyzed and discussed. The results lead to the conclusion that, owing to the inherent characteristics of the system and to the specific design, occurrences are well within the limits of a typical probability release criterion. (auth)

5635 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS. Moeller, D. W. (Harvard School of Public Health, Boston). Health Phys.; 28: No. 3, 177–187(Mar 1975).

For over 25 years, the Advisory Committee on Reactor Safeguards has had primary responsibility for conducting independent reviews and evaluations of the health and safety aspects of nuclear power reactors, chemical processing plants, and associated activities within the nuclear fuel cycle. Through the support of its subcommittees and working groups, the committee currently issues summary reports on 25 to 30 nuclear facilities and safety related questions each year. Topics discussed include the views and thoughts of the committee with respect to emergency core cooling systems, fuel densification, anticipated transients without scram, reactor pressure vessel failure, turbine missiles, steamline breaks, environmental monitoring, waste management and seismicity. Major portions of the activities, interests, and responsibilities of the committee are of direct importance to health physicists and the radiation protection profession. (auth)

5636 ENVIRONMENTAL EFFECTS OF COOLING SYSTEMS AND THERMAL DISCHARGES AT NUCLEAR POWER STATIONS. Int. At. Energy Agency Bull.; 16: No. 6, 28–32(Dec 1974).

Projections of nuclear power growth are related to the growing problem of waste heat disposal. Specific adverse effects of thermal effluents are mentioned, and studies being carried out to measure environmental effects and possible applications of waste heat are discussed. (DG)

5637 THERMODYNAMIC DESCRIPTION OF THE MAXIMUM POSSIBLE ACCIDENT WITH WATER-COOLED REACTORS (LWR). Constantinescu, S. (Institut Polytechnique, Bucharest). Rev. Roum. Phys.; 19: No. 6, 661–666(1974). (In French).

An attempt is made to establish a system of differential equations which can furnish a correct description of the complex thermal and hydraulic phenomena occurring in the maximum possible accident of an LWR. The system is established in an irreversible formalism. (JSR)

5638 NUCLEAR SAFETY CONTROVERSY (CONT.). Chem. Eng. Progr.; 71: No. 3, 26–31(Mar 1975).

The more important sections of the WASH-1400 Summary Report ("An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants") are reproduced. Data on fatality risks due to various man-made and natural causes are compared to risks calculated for nuclear power plants. (DG)

5639 NUCLEAR POWER PLANT SITING ON DEEP ALLUVIUM. Scott, R. F. (California Inst. of Tech., Pasadena); Schoustra, J. J. J. Geotech. Eng. Div., Amer. Soc. Civil Eng.; 100: No. GT4, 449–459(Apr 1974).

From ASCE national structural engineering meeting: San Francisco, CA (9 Apr 1973).

The following questions concerning nuclear plant siting on deep alluvium are examined. (1) Are the site foundation materials dynamically stable, in particular with respect to liquefaction and vibration-induced settlements. (2) What is the effect of this alluvium on the ground motion produced by an earthquake. (3) Can an assessment of the risk of fault rupture beneath the site be made with at least the same confidence as for sites where bedrock is near the surface. (auth)

5640 TESTING TECHNIQUES FOR SIMULATING EARTHQUAKE MOTION. Kao, G. C. J. Environ. Sci.; 18: No. 2, 22; 31–40(1975).

A significant number of nuclear powered generating stations have been built or are under construction in order to meet the increasing demand for electrical power. Unfortunately, many of these stations are located in earthquake susceptible areas. In order to minimize failures of critical equipment or components during earthquakes, it is required that a large portion of such equipment be tested to simulated earthquake motions to insure that vital functions can be maintained to avoid malfunction of the entire power generating system, or, in case of failure, an orderly shut down sequence can be executed. The objective of this article is to present existing testing techniques applicable to the qualification of equipment to earthquake environments. The emphasis of the discussion will be centered in the areas of test criteria, exciter systems and control systems so that basic testing principles required to implement earthquake testing requirements can be fully understood. In addition, a list of selected references related to

earthquake simulation testing is presented in the Bibliography section for further reference. (auth)

5641 NUCLEAR INSURANCE. Nucleonics Week Special Report. New York; McGraw-Hill, Inc. (1974). 15p.

News items selected from Nucleonics Week concerning nuclear insurance are presented. (JWR)

5642 PREDICTION OF CROSS FLOW DUE TO COOLANT CHANNEL BLOCKAGES. Brown, W. D. (Army Engineer School, Ft. Belvoir, VA); Khan, E. U.; Todreas, N. E. Nucl. Sci. Eng.; 57: No. 2, 164-168(Jun 1975).

Computer programs such as COBRA IIIC, which handle flow blockages, use a transverse momentum balance on a control volume of uniform width connecting any two subchannels to evaluate cross flow and momentum exchange effects on axial flow distribution. The transverse momentum balance employed has several constants that need to be determined empirically. The method to develop such a correlation for three blockage configurations is described. It was found that with a constant width control volume, the data could not be satisfactorily correlated. A variable width control volume was therefore used to correlate the data behind flow blockage. A similar correlation could be developed ahead of the blockage but is not completed yet. Although the applicability of the correlation is limited to the blockage configurations analyzed, the variable width control volume method of correlating data that has evolved from this study is of general use in correlating such data. (auth)

5643 NUCLEAR CONTROVERSY: AMONG SCIENTISTS AND TECHNOLOGISTS, POLITICIANS, AND IN MASS MEDIA. Loefveberg, S. (Statens Straalskyddinstitut, Stockholm). Ingenioer-nytt; 11: No. 9, 4-6(7 Mar 1975). (In Norwegian).

From conference on nuclear power: should we have doubts; Oslo, Norway (11 Feb 1975).

The history of the nuclear controversy is briefly described and the opinion is expressed that the utilities and politicians failed to react to the first signs and then reacted with misplaced information. The criticism of nuclear power has changed its targets progressively, normal operation hazards and transport risks are generally accepted now and the criticism of accident hazards is receding. Criticism of waste disposal seems to have culminated and it is now plutonium which forms the main aspect in criticism. The international aspects of the nuclear controversy are then discussed and it is pointed out that while the US has led the way, trends occur there which are not necessarily repeated elsewhere. The debate in central Europe has seldom reached the authorities and utilities, while in Japan it has taken a militant form. In the UK and Canada there has been almost no debate. It is significant that in countries with a low standard of living nuclear power is accepted as means of raising the standard. No debate takes place in the east European countries. The nuclear debate in Sweden has been lively for the past ten years and is an echo of the US debate. It has spread to Finland through the Swedish language press there. The present status in the controversy regarding normal operation, accidents, plutonium and high active waste is discussed. (NO)

5644 BEHAVIOUR OF SNR FUEL ELEMENTS UNDER COOLANT-LOSS CONDITIONS. II. Kwast, H. Atoomenergie Haar Toepass.; 17: No. 3, 54-60(Mar 1975). (In Dutch).

In-pile experiments are described in which various coolant-loss situations are deliberately induced, so as to study the effects of such failures on SNR fuel elements under operational conditions. Results of in-pile and out-of-pile experiments are compared and discussed. Certain recommendations are made for modifications, to both the system design and the operating sequences, which should minimize the risk of coolant loss and limit its consequences, should it ever occur. (NL)

5645 RELIABILITY TECHNIQUES APPLIED TO NUCLEAR POWER PLANT SYSTEMS. Solomon, K. A. Los Angeles; Univ. of California (1974). 372p. University Microfilms Order No. 75-9437.

Thesis (Ph. D.).

Methods using probabilistic techniques are developed and applied to estimate the integrity and reliability of nuclear power plant systems in this dissertation. Two diverse power plant systems are selected for study. The primary objective of the first study is to develop a simple methodology which, when coupled with existing observations on pressure vessel behavior, provides an inter-relation between nuclear pressure vessel weld integrity and the parameters of the in-service inspection program, including inspection sample size, frequency, and efficiency. A modified Markov process is employed and a computer code written to obtain numerical results. Based on the model developed, the predicted number of critically sized defects predicted per nuclear pressure vessel weld at the end of weld life is about 6×10^{-7} per weld for welds under both high and low average stress if ASME, Section XI, In-Service Inspection requirements are applied. Based on British data and the less stringent inspection standards, (compared to Section XI), the estimated number of critically sized defects per weld at the end of weld life is 250×10^{-7} and 170×10^{-7} per weld for high and low stressed welds, respectively. The primary objective of the second study is to determine the start up availability and operating reliability of the Core Auxiliary Cooling System, CACS, of a High Temperature Gas Cooled Reactor, HTGR, following the simultaneous occurrence of a Design Basis Depressurization Accident, DBDA, and the complete Loss of Main Loop Cooling, LOMLC. The CACS is an emergency standby cooling system comprised of two legs in the smaller HTGR and three in the larger HTGR. Under most circumstances only n – 1 out of n of these legs need to be activated and remain operational to assure adequate core cooling. Considering system design, system function, assumed component failure rates, assumed component maintenance, the potential for destructive maintenance, the potential for inaccurate inspection, and the postulated influence of common mode failures, the estimated CACS unavailability varies between 4×10^{-7} and 3×10^{-5} for the smaller plant and 5×10^{-7} and 5×10^{-5} for the larger plant. At the end of 300 hours, the estimated probability that the CACS will not have sufficient core cooling capability varies between 5×10^{-5} and 4×10^{-2} for the smaller plant and 6×10^{-5} and 6×10^{-2} for the larger plant. The estimated probability that a single CACS leg will fail to activate on command varies between 1×10^{-4} and 1×10^{-3}, and the estimated probability that a single CACS leg will not be functional at the end of 300 hours varies between 6×10^{-3} and 1×10^{-1}. (Diss. Abstr. Int., B)

5646 LIST OF INCIDENTS IN NUCLEAR POWER PLANTS. Umwelt (Inf. Bundesminist. Innern).; No. 35, 14-18(Oct 1974). (In German).

A condensed compilation and review is presented of incidents in nuclear power plants of which notice has been given either to the Reactor Safety Commission (RSK) or the Committee for internal affairs of the Bundestag, covering the period from October 1971 to September 1974, including the causes and consequences of failures. Plants under review included: KNK, KWO, KKW, KWL, Merlin, KRB, KKS. None of the incidents reported involved uncontrolled release of radioactivity, or releases of unduly high amounts of radioactivity to the environment, nor has there been damage to the population. (GE)

5647 THE EFFECTS OF DEFORMATION ON THE HIGH-TEMPERATURE STEAM OXIDATION OF ZIRCALOY-2. Bradhurst, D. H.; Heuer, P. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights. Materials Div.). J. Nucl. Mater.; 55: No. 3, 311-326(Mar 1975).

An experimental study was made of the effects of deformation on the oxidation of Zircaloy-2 reactor fuel cladding in flowing steam in the temperature range 700 to 1300°C. The kinetics and mechanism of oxygen penetration and embrittlement were examined using gravimetric and metallographic methods. Tensile deformation during oxidation resulted in cracking of the growing oxide and local oxidation of the metal at the base of the crack. The number of points of local attack was inversely related to the temperature of oxidation. The depth of local penetration of the metal (in excess of the uniform depth of penetration for undeformed cladding) was greatest when the deformation rate was slow. The maximum depth of local attack found in these experiments was equivalent to an increase in total oxygen penetration of about twice that due to uniform diffusion. The possible relevance of these results to the analysis of reactor loss-of-coolant accidents is discussed. (auth)

5648 CALCULATION OF THE DYNAMIC RESPONSE OF REACTOR CONTAINMENT SYSTEMS TO FULL CORE EXPLOSIONS. Cowler, M. S.; Hoskin, N. E.; Rowlinson, A. G. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Comput. Phys. Commun.; 9: No. 2, 69-78(Feb 1975).

ASTARTE, a comprehensive time-dependent two-dimensional Lagrangian hydrodynamic code, has been developed to determine numerically the loadings and strains arising within the primary containment system following a high-energy reactor excursion. The detail, both temporal and spatial, which is achievable by judicious use of such a code allows the safety analyst to examine the response of individual sections of the containment. It is possible, furthermore, to predict the effects on the history of a given reactor accident of variations in the basic characteristics of the components making up the containment system. To validate this approach an extensive analysis using ASTARTE has been made of model excursion experiments for a single tank pool-type reactor system. Results demonstrate clearly the ability to accurately reproduce numerically the measured loadings and impulses around the confining tank. Considerable emphasis is placed on the necessity to define accurately the constitutive relations and to determine the stress-strain behavior of all components included in the simulated reactor system. (auth)

5649 FLOATING NUCLEAR POWER STATIONS. Programme and State of Technology in the USA in 1974. Zechella, A.; Klein, E. G. (Westinghouse Electric Corp., Jacksonville, Fla. (USA)). VGB Kraftwerkstechnik; 54: No. 12, 771-775(Dec 1974). (In German).

A brief explanation is given of the actual problems of the electricity supply undertakings in the setting up of nuclear power plants. It is expected that these problems will be greatly reduced by a quantity production of standardized floating nuclear power plants. A report is given on the main characteristics of this concept and on the present working state on a production line for floating nuclear power plants in the USA. (GE)

5650 ATOMRECHT. Nutzungsmoeglichkeiten und Gefahren der Atomenergie. Mit Gesetzen und Verordnungen. (Atomic Energy Law. Range of Applications and Hazards of Nuclear Energy. With Laws and Regulations). Kimminich, O. Das Wissenschaftliche Taschenbuch. Muenchen, F. R. Germany; Goldmann (1974). 336p. (In German).

The book aims to simplify the approach to legal matters for the non-jurists as well as for the jurists who deal with economy, administration, law and legal advice. It is meant to be a lecture replacement for university law students. (GE)

Reactor Theory and Calculation

Refer also to abstracts 5102 and 5422.

5651 (AD/A-002986) STABILITY PROPERTIES OF AN EQUATION ARISING IN REACTOR DYNAMICS. Lecture Notes. Infante, E. F.; Walker, J. A. (Brown Univ., Providence, R. I. (USA)). Nov 1974. Contract N00014-67-A-0191-0009. 23p. NTIS $3.25.

The stability of a system of integradifferential equations which arise as dynamic models of one-dimensional continuous-medium nuclear reactors is studied. It is shown that the system generates a nonlinear co-semigroup on a Hilbert space, and extensions of Liapunov's direct method are then applied to obtain conditions for the asymptotic behavior of the solutions. (GRA)

5652 (A.R.E.A.E.E.-191) CALCULATION OF THERMAL SPECTRA IN HOMOGENEOUS MEDIA BY THE SYNTHETIC SCATTERING KERNEL MODEL. Hathout, A. M.; Hamouda, I. (Atomic Energy Establishment, Cairo (Egypt)). 1974. 19p. Dep. NTIS (US Sales Only) $4.00.

The transport equation is solved numerically using the secondary model introduced by Cadilhac. The thermalized neutron spectra is calculated using 40 energy groups in the thermal region, in the range from 0.0 to 36 kT (1 kT is equal to 0.025 eV). A FORTRAN-II program is written for IBM-1130, to calculated thermal spectra for graphite and water as two separate homogeneous moderators. Results for water were compared with experiments done at UA-RR-1, while for graphite were compared with that of previous works. Quite good agreement was obtained. (17 references) (auth)

5653 (BNWL-SA-5183) TRANSIENT HYDRAULIC ANALYSIS FOR REACTOR CORES. Rowe, D. S.; Stewart, C. W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). [nd]. Contract AT(45-1)-1830. 7p. (CONF-750406-3). Dep. NTIS $4.00.

From ANS topical meeting on computational methods in nuclear engineering; Charleston, South Carolina, USA (15 Apr 1975).

Mathematical solution approaches for lumped-parameter equations used in nuclear rod-bundle thermal-hydraulic analysis are presented. In the lumped-parameter approach the cross section is divided into subchannels which are further subdivided axially to form a three-dimensional array of control volumes for analysis. The lumped parameter mathematical models are written in various degrees of sophistication for both single- and two-phase flows for water, liquid-metal and gas-cooled reactors. This discussion is limited to a homogeneous thermal-equilibrium flow without sonic velocity propagation. This allows fluid mixture density to be expressed in terms of fluid enthalpy. The methods have been incorporated into the COBRA computer program and are providing important new computational capabilities for reactor safety analysis. (auth)

5654 (CONF-741065-15) STUDY OF THE POWER SPECTRAL DENSITY BY A NONLINEAR RESPONSE TO THE STOCHASTIC INPUT. Gotoh, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). 1974. 22p. Dep. NTIS (US Sales Only) $4.25.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

The non-linear response of a reactor to a stochastic reactivity input has been studied. The conditions for the system to be stable in the mean and in the mean square sense are derived for the Gaussian steady and for the white noises. An integral equation for the power spectral density is obtained from the ensemble average of the equation for a covariance function and its Fourier transformation. The integral equation includes the effect of a non-linear response to the stochastic input. (auth)

5655 (COO-2515-1) DEVELOPMENT OF A LUMPED PARAMETRIC MODEL FOR SCOPING INVESTIGATIONS OF UNCERTAINTIES IN FAST REACTOR PROBABILISTIC SAFETY ANALYSIS. Progress Report, October 1, 1974–March 31, 1975. Ott, K. O.; Luck, L. B. (Tufts-New England Medical Center, Boston, Mass. (USA)). 1975. Contract AT(11-1)-2515. 9p. Dep. NTIS $4.00.

A computational method for solving reactor kinetic problems with adequate accuracy and much less computational expense is under development. It is based on describing the reactor state by means of various volumetric distributions (fuel volume, cladding volume, coolant volume, etc.; as functions of temperature and fuel power density (for fuel volume only). Progress is reported. (LTN)

5656 (IBK-1283) RESEARCH ON BURNUP PHYSICS. Pop-Jordanov, J. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1974. 12p. INIS.

One of the major problems in burnup studies is the reasonably fast and accurate calculation of the space-and-energy dependent neutron flux and reaction rates for realistic power reactor fuel geometries and compositions, and its optimal integration in the global reactor calculations. The scope of the research described was to develop improved methods for satisfying the above requirements. The research on epithermal region is finalized in computing program SPLET, which calculates the space-lethargy distribution of the spherical harmonics neutron flux moments and the related integral quantities as reaction rates and resonance integrals. For partial verification of the above methods a Monte Carlo procedure was developed. Using point-wise representation of variables, a flexible and fast convergent integral transport method SEPT is developed. Expanding the neutron source and flux in finite series of arbitrary polynomials, the space-and-energy dependent integral transport equation is transformed into a general linear algebraic form, which is solved numerically. A multizone few-group program SPECTAR for global reactor calculations was developed. For testing, the flux distribution, neutron leakage and effective multiplication factor for the PWR reactor of the power station San Onofre were calculated. In order to verify the validity of the equivalent material buckling definition, measurements were performed on experimental heavy water zero power reactor RB in Vinca, for three lattice pitches and lattice mixes of two kinds of fuel elements. The application of quasilinear programming for solving the control rod distribution problem to achieve maximum average fuel burnup resulted in a flexible optimization procedure. (INIS)

5657 (JAERI-M-5658) ARCADIA-I: ON-LINE SYSTEM FOR CROSS SECTION ADJUSTMENT BY GRAPHIC DISPLAY. Adjustment by Interpolation. Nakamura, Y.; Onuma, Y.; Kuroi, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). Apr 1974. 47p. INIS.

The on-line graphics system ARCADIA-I, which adjusts cross section library AGLI for fast reactor analysis, has been developed for the F230-35 ROS system. In ARCADIA-I, the CRT, lightpen, and alphanumerical keyboard can be used effectively. Appropriate adjustment of the AGLI library can be made easily and visually. The adjusted library can also be used as input to the computer codes for reactor physics analysis in the F230-60 system. (auth)

5658 (RT/FI-(74)47) REVIEW OF INTERNATIONAL NOISE CONFERENCE HELD IN ROME (OCTOBER 1974). Pacilio, N.; Jorio, V. M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Dec 1974. 28p. (CONF-741017-34). Dep. NTIS (US Sales Only) $4.75.

From meeting of the American Nuclear Society; Washington, District of Columbia, USA (27 Oct 1974).

SMORN-1 (Specialist Meeting on Reactor Noise-1) has been sponsored by the Nuclear Energy Agency Committee on Reactor Physics, hosted by the Italian National Committee for Nuclear Energy and held at C. S. N. Casaccia, Rome, Italy, from October 21 to 25, 1974. The object of SMORN-1 was to discuss every type of noise related to reactor systems: inherent noises and induced noises by imposed perturbations of stochastic or pseudo-stochastic nature. The meeting dealt with fluctuations from sources such as boiling and temperature, acoustic monitoring of anomalies and various diagnosing of malfunctioning via noise analysis. The basic idea was that of covering the widest possible area and to understand where the borderlines with other disciplines are. Sixty-one participants from twenty-three countries and/or organizations have been attending the five-day meeting and forty-six

papers were presented. An up-to-date international picture of the state-of-the-art in both noise theory and experiment was obtained and directions on where to go next developed. (auth)

5659 (WANL-TMI-915) DIGITAL DYNAMIC REACTOR. Drawbaugh, D. W. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Jan 1964. 13p. Dep. NTIS $4.00.

Variational methods for averaging reactor lattice parameters over dimensions large compared to individual cell dimensions are presented. (JWR)

5660 SIMPLE METHOD FOR CALCULATING THE ANISOTROPY OF NEUTRON DIFFUSION IN HETEROGENEOUS REACTORS. Williams, M. M. R. (Queen Mary Coll., London). J. Inst. Nucl. Eng.; 15: No. 6, 163-170(Nov 1974).

A simple method for calculating anisotropic diffusion coefficients in reactor lattices is developed. Diffusion theory is used throughout; and no appeal is made to any transport theoretical arguments. In this way it is hoped to introduce the basic ideas of streaming and anisotropic diffusion at a level suitable for teaching purposes. Expressions are obtained for the axial and transverse diffusion coefficients in terms of averages over the normal lattice flux and also in terms of a new, so-called "tilted" flux. Numerical examples are given which assess the accuracy of the equivalent cylindrical cell "Wigner-Seitz" approximation. Also given, but not discussed in any detail, are some numerical results which illustrate the limitations of diffusion theory for this type of problem. (UK)

5661 TIME DISTRIBUTION FUNCTION IN A COUPLED CORE REACTOR. Lazarescu, G. A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 19: No. 10, 1087-1093(1974).

The time distribution function plays an important role in the kinetics of a coupled reactor. Time distribution function models used in coupled reactor kinetics are presented. For the improvement of the kinetics models for the coupled reactors with important spectral coupling effects, two new time distribution function models are proposed. (auth)

5662 ZERO-POWER NOISE ANALYSIS IN A REACTOR WITH TWO WEAKLY COUPLED ASYMMETRICAL FISSION ZONES. Viehl, E. (Physikalisch-Technische Bundesanstalt, Bundesalle, Ger.). Nucl. Sci. Eng.; 56: No. 4, 422-427(Apr 1975).

Analytical expressions describing the measured auto- and cross-spectral densities of the zero-power noise at the Measuring and Research Reactor Braunschweig (FMRB) were derived from the two-point reactor kinetics equations. By means of this theory, the following properties of the two fission zones of the assembly were obtained from measurements: (a) the shutdown reactivities of the isolated cores, (b) the coupling reactivity, and (c) the power in the fission zones. The efficiencies of the detectors, needed to evaluate the properties mentioned, were obtained from these measurements also. The influence of the delayed neutrons–which were neglected when estimating the properties of the FMRB–on the coherence function is shown. This function was used to detect coupling effects in extended cores. (auth)

5663 POWER REACTOR CALCULATIONS WITH THE FINITE ELEMENT PROGRAM FEM 2D. Schmidt, F. A. R.; Franke, H. P. (Univ. Stuttgart). Nucl. Sci. Eng.; 56: No. 4, 431-433(Apr 1975).

A program for the solution of the two-dimensional diffusion equation by the finite element method was developed and applied to realistic reactor calculations. Comparisons were made with well-known diffusion theory codes and with nodal programs. Results of these comparisons and first experiences with the finite element method and its success in the FEM 2D program are reported. (auth)

5664 TRANSMISSION PROBABILITY METHOD OF INTEGRAL NEUTRON TRANSPORT CALCULATION FOR TWO-DIMENSIONAL RECTANGULAR CELLS. Haeggblom, H. (AB Atomenergi, Nykoeping, Sweden); Ahlin, A.; Nakamura, T.; Ahlin, A. Nucl. Sci. Eng.; 56: No. 4, 411-422(Apr 1975).

A theory is described for solving the integral neutron transport equation by the transmission probability method. Detailed attention is given to the problem in rectangular x-y geometry. Within a mesh the neutron flux is assumed to be linearly dependent on the x and y coordinates. The angular dependence is given by a double P_1 approximation. At the mesh surfaces a term is considered that allows for an asymmetric flux distribution relative to the surface normal. The inner source is obtained from the equilibrium equation. Based on this method, the code COXY has been developed and applied to one- and two-dimensional rectangular cell calculations. The calculated results show good agreement with those of S/sub N/ and collision probability codes. (auth)

5665 NONLINEAR OSCILLATIONS IN A REACTOR WITH TWO TEMPERATURE COEFFICIENTS. Keener, J. P.; Cohen, D. S. (Univ. of Arizona, Tucson). Nucl. Sci. Eng.; 56: No. 4, 354-359(Apr 1975).

A multi-scale perturbation method for studying nonlinear oscillations and their stability in higher order systems is developed. The technique is applied to the two-temperature reactor model. Stability boundaries involving the various parameters are established, and easily interpretable analytical expressions for nonlinear oscillations are presented. The method requires neither phase plane systems nor autonomous equations and thus provides an analytical tool for investigating higher order and space-dependent reactor models. (auth)

5666 VARIATIONAL FUNCTIONALS WHICH ADMIT DISCONTINUOUS TRIAL FUNCTIONS. Nelson, P. Jr. (Texas Tech Univ., Lubbock). Nucl. Sci. Eng.; 56: No. 4, 340-353(Apr 1975).

It is argued that variational synthesis with discontinuous trial functions requires variational principles applicable to equations involving operators acting between distinct Hilbert spaces. A description is given of a Roussopoulos-type variational principle generalized to cover this situation. This principle is suggested as the basis for a unified approach to the derivation of variational functionals. In addition to esthetics, this approach has the advantage that the mathematical details increase the understanding of the derived functional, particularly the sense in which a synthesized solution should be regarded as an approximation to the true solution. By way of illustration, the generalized Roussopoulos principle is applied to derive a class of first-order diffusion functionals which admit trial functions containing approximations at an interface. These "asymptotic" interface quantities are independent of the limiting approximations from either side and permit use of different trial spectra at and on either side of an interface. The class of functionals derived contains as special cases both the Lagrange multiplier method of Buslik and two functionals of Lambropoulos and Luco. Some numerical results for a simple two-group model confirm that the "multipliers" can closely approximate the appropriate quantity in the region near an interface. (auth)

5667 GENERALIZED DIFFUSION THEORY FOR CALCULATING THE NEUTRON TRANSPORT SCALAR FLUX. Alcoufee, R. E. (Los Alamos Scientific Lab., NM). Nucl. Sci. Eng.; 56: No. 4, 321-339(Apr 1975).

A generalization of the neutron diffusion equation is introduced, the solution of which is an accurate approximation to the transport scalar flux. In this generalization the auxiliary transport calculations of the system of interest are utilized to compute an accurate, pointwise diffusion coefficient. A procedure is specified to generate and improve this auxiliary information in a systematic way, leading to improvement in the calculated diffusion scalar flux. This improvement is shown to be contingent upon satisfying the condition of positive calculated-diffusion coefficients, and an algorithm that ensures this positivity is presented. The generalized diffusion theory is also shown to be compatible with conventional diffusion theory in the sense that the same methods and codes can be used to calculate a solution for both. The accuracy of the method compared to reference S/sub N/ transport calculations is demonstrated for a wide variety of examples. (auth)

5668 MULTILEVEL APPROACH TO NUCLEAR FUEL BURNUP OPTIMIZATION. Ciechanowicz, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng.; 57: No. 1, 39-52 (May 1975).

The aim of the paper is to show how the complex, overall burnup optimization problem, subject to the constraint of the desired power distribution, can be solved by decomposition into less complex coordinated subproblems. The solution has been obtained by use of the multilevel approach. The advantage of this approach is that it makes the computer solution of the problem of optimization practical. Two decomposition structures are considered: one for discrete and one for continuous reactor refueling. In the second case the optimization problem subject to the constraint in a form of an inequality containing a differentiable operator is analyzed. To solve this problem the generalized Kuhn-Tucker theorem is used. To determine the optimum control of the desired power distribution, the Kulikowski approach is applied. As a result, the cyclic optimization process for both structures is obtained in which the information is exchanged between suitable level controllers. (auth)

5669 EXAMINATION OF THE CAPABILITIES OF THE PHASE SPACE TIME EVOLUTION METHOD APPLIED TO NEUTRON TRANSPORT. Jones, R. B. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Tavel, M. Nucl. Sci. Eng.; 57: No. 1, 90-92(May 1975).

The accuracy of the phase space time evolution method applied to neutron transport is contrasted with a one-dimensional discrete

ordinates code with anisotropic scattering, ANISN, a time-dependent explicit discrete ordinates code, TIMEX, and theoretical benchmark values for critical bare slabs. The comparison is performed by calculating the critical value of ν (the number of neutrons released per fission) for slabs of various halfwidths. Furthermore, pointwise flux differences are displayed for one particular slab thickness. Finally, a nonlinear time-dependent problem previously solved only in diffusion theory is considered. (auth)

5670 SOME ADDITIONS TO REACTOR NOISE THEORY WHICH INCLUDE DELAYED NEUTRONS. Wang, H. K.; Ruby, L. (Univ. of California, Berkeley). Nucl. Sci. Eng.; 57: No. 1, 86-90 (May 1975).

The general theory of reactor noise in the time domain for a zero-power reactor is formulated by using an equation for the probability generating function (pgf). With suitable manipulations of the pgf, several previously known theoretical results from noise analysis in the time domain can be deduced from this general theory. Although the detection process is not treated generally, a new result is the explicit determination of the pgf for the case where delayed neutrons are considered. (auth)

5671 ACCURATE EXTRAPOLATION LENGTHS FOR PULSED MONOENERGETIC NEUTRONS IN SLABS AND SPHERES. Sjoestrand, N. G.; Dahl, E. B. (Chalmers Univ. of Technology, Goteborg). Nucl. Sci. Eng.; 57: No. 1, 84-86 (May 1975).

With recently published results of Kaper et al. as a basis, accurate extrapolated endpoints have been calculated for homogeneous pulsed slabs and spheres. The neutrons were assumed to be monoenergetic and to scatter isotropically. In contrast to P_3 calculations, the results indicate a zero slope at small bucklings of the curve describing the extrapolated endpoint as a function of buckling. (auth)

5672 NEW METHOD FOR THE NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL NEUTRON DIFFUSION EQUATION. Aoki, K.; Tsuiki, M. (Nippon Atomic Industry Group Co., Kawasaki, Japan). Nucl. Sci. Eng.; 57: No. 1, 53-62 (May 1975).

A new method for the numerical solution of the two-dimensional diffusion equation was developed, namely, the analytic solutions in neighboring mesh regions were discretely connected at the mesh points to obtain a five-point linear equation similar to the conventional finite-difference equation. A series of test calculations performed for thermal and fast reactors shows that the new method effectively reduces the number of mesh points, and hence computation time and memory, required to attain the same computational accuracy as does the conventional finite-difference method. (auth)

5673 REEVALUATION OF THE EMISSION PROBABILITIES OF DELAYED NEUTRONS FROM FISSION PRODUCTS. Izak-biran, T.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Sci. Eng.; 57: No. 2, 117-121 (Jun 1975).

The emission probabilities of delayed neutrons are reevaluated on the basis of recently determined fission yields. The accuracy of the probabilities for thermal and fast fission of ^{233}U and ^{235}U is examined by summation of the individual delayed-neutron yields of the precursors and by comparison with the unseparated group and directly measured total delayed-neutron yields. The good agreement of the results obtained by the two independent methods indicates that the derived probabilities are accurate enough for the calculation of delayed-neutron yields for other fissioning systems and for reactor calculations. (auth)

Reactor Components and Accessories

Refer also to abstracts 4046 and 5645.

5674 (AED-CONF-74-571-005) CONTRIBUTION TO EVALUATION OF MIXED OXIDE CORE PERFORMANCE FROM DATA OBTAINED IN ITALIAN EXPERIMENTAL PROGRAMS. Ariemma, A.; Paoletti, M.; Zaffiro, B.; Lepscky, C.; Pistella, F.; Testa, G. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1974. 19p. INIS.

From panel on plutonium utilization in thermal power reactors; Karlsruhe, F. R. Germany (25 Nov 1974).

To gather experimental information on plutonium assembly performance irradiated in the Garigliano BWR reactor, gamma scanning and hot-cell destructive measurements were carried out. The main results obtained on power distributions from gamma scanning performed in 1968 during open-vessel critical experiments and in 1970 at the end of the first irradiation cycle have already been published. This paper provides the results of the further investigations carried out so far and relates mainly to the post-irradiation examinations (PIE) of plutonium rods removed from assemblies after one or two irradiation cycles and to the rod-by-rod gamma scanning of a fuel assembly discharged at the end of cycle 2. A general outline is also given of the results of the irradiation experiments carried out in the Aegesta and Kahl reactors with CNEN-designed and -manufactured prototype plutonium assemblies, and of the feasibility assessment of using gadolinium as burnable poison. (GE)

5675 (AED-CONF-74-590-002, pp vp) EXPERIENCE DURING THE DECONTAMINATION OF REACTOR COMPONENTS. Baehr, W.; Dippel, T.; Kienhoefer, M. 1974. (In German).

From VGB conference on "power plant auxiliaries 1974"; Essen, F. R. Germany (4 Dec 1974).

In power plant auxiliaries 1974. Papers. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (F. R. Germany)).

A report is given on the operational experience gained at the decontamination plant, Karlsruhe from 1963-1973. It is thus shown that the decontamination of expensive or hard-to-get equipment is always worthwhile. The expenditure is as a rule about 10-20% of the value of the equipment. (GE)

5676 (AED-CONF-74-590-004, pp vp) WATER RING VACUUM PUMPS AS COMPACT UNITS FOR THE VENTING OF STEAM TURBINE CONDENSERS IN CONVENTIONAL AND NUCLEAR PLANTS. Salm, P. 1974. (In German).

From VGB conference on "Power Plant Auxiliaries 1974"; Essen, F. R. Germany (4 Dec 1974).

In power plant auxiliaries 1974. Papers. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (F. R. Germany)).

A report is given on the assembly and typical characteristics of an isothermally condensing one-stage ELMO water ring vacuum pump. (GE)

5677 (CONF-731218-P1) SEMINAR ON IODINE FILTER TESTING, KARLSRUHE, WEST GERMANY, 4-6 DECEMBER 1973. Volume I. (Commission of the European Communities, Luxembourg). Mar 1974. 582p. (In Several Languages). Commission of the European Communities.

A total of 31 papers dealing with iodine removal systems is presented. Each paper has been separately indexed and abstracted for NSA. (DG)

For abstracts of individual papers see: 3158, 3159, 3440, 3441, 5314-5316, 5349-5354, 5373, 5411, 5601, and 5678-5692.

5678 (CONF-731218-P1, pp 1-24) BEHAVIOR OF IODINE SORPTION MATERIALS. Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

All iodine compounds to be found in the air vented from nuclear power plants are listed. The chemical reactions by means of which fission-product iodine is retained by the sorption materials are explained briefly. The importance of the main parameters affecting the layout of sorption beds, such as type and grain size of the sorption material and relative humidity and temperature of the carrier gas, is discussed with reference to experimental results. Experiences on the dependence of the retention efficiency on the concentration of elementary iodine and methyl-iodide in the air are reported. The results are given of residence time experiments on the ageing and poisoning of the sorption material, and measures to prolong service life are discussed. (auth)

5679 (CONF-731218-P1, pp 121-148) AGING OF IMPREGNATED CHARCOALS. Taylor, L. R.; Taylor, R. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Activated charcoals impregnated with potassium iodide or triethylenediamine are widely used for the trapping of iodine species. A description is given of laboratory work on accelerated dynamic ageing and real-time static ageing of impregnated charcoals. From the investigations an equation, which allows predictions of ageing performance to be made, has been developed. The predictions of the ageing equation are compared with the results obtained from the real-time dynamic ageing performance of an installed full-scale iodine trapping plant. (auth)

5680 (CONF-731218-P1, pp 163-173) IODINE SORPTION PLANTS FOR NUCLEAR POWER STATIONS. Strauss, H. J.; Staschik, G.; Winter, K. (CEAG Dominit AG, Dortmund, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

To prevent radioactive leaks into the atmosphere, such as radioactive iodine and its organic compounds, the air in the containment building which may contain radioactive fission product iodine after an incident must be prevented from escaping into the atmosphere. This can be done if (a) the containment is completely airtight, or (b) the pressure in the containment is maintained below atmospheric pressure. Since there is an increase in pressure every time an incident occurs through the release of heat energy and since a containment can never be kept absolutely airtight, there are two possible solutions: (1) a double-walled containment can be built, so that any polluted air escaping from the annular space between the two containments is sucked out and cleaned in absolute filters, or (2) provision can be made within a single-wall containment for a rapid extraction of heat and hence a rapid release of the pressure as it builds up and a rapid reduction in the level of atmospheric contamination by recirculating the air through a containment filter. Because the trapping of radioactive iodine or organic iodine compounds by charcoal is temperature dependent, it has been found advantageous to put inorganic adsorbents into the containment filters, which have been specially fitted. These adsorbents can be placed either in flat or circular layers, the latter being more effective in meeting the requirements. In this case adsorption can be maintained up to a temperature of 300°C, if the adsorbents built up on a ceramic base are specially impregnated. (auth)

5681 (CONF-731218-P1, pp 211-235) TESTING OF IODINE FILTER SYSTEMS. Wilhelm, J. G.; Dillmann, H. G.; Gerlach, K. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The method used in the Federal Republic of Germany for testing iodine filters for nuclear plants consists of batch testing the sorption material under normal and simulated incident conditions, and in situ testing of the filters after installation. In addition to this, sorption material from test filters, which are situated in a by-pass line to the filter's sorption section, are examined at appropriate intervals. The methods and equipment used in testing are described and discussed in detail. Based on the experience obtained, proposals are made concerning the extent to which filter testing will be carried out in the future. The proposals are intended to form the background of discussions on a uniform method of testing. (auth)

5682 (CONF-731218-P1, pp 237-257) IODINE SORPTION PLANT TEST PROCEDURES IN THE UNITED KINGDOM. Hillary, J. J. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The United Kingdom approach to performance monitoring of Iodine Sorption Plant combines in-situ testing at full-scale with laboratory tests of the sorbent (usually impregnated charcoal) using a realistic labelled iodine compound, methyl iodide-131. Plant performance can then be evaluated under a wide variety of operational conditions difficult to achieve conveniently on the plant. Essentially, the full-scale test gives a measure of the extent to which gas may by-pass the charcoal. Laboratory testing is also important in the assessment of in-service performance of the sorbent, to check ageing and possible poisoning effects. In a typical large scale test, the source is released upstream of the plant. Penetration is measured by withdrawing a proportion of the main gas flow through charcoal samplers situated in upstream and downstream locations and comparing the sampler activities. There is considerable experience in the conducting of these large scale tests with milli-curie levels of methyl iodide-131 according to well developed safety procedures. The laboratory test for iodine sorption materials is carried out with methyl iodide-131 in air at near 100% relative humidity. This represents rather pessimistic operating conditions which can conveniently be achieved reproducibly. Performance is again measured by charcoal samplers. (auth)

5683 (CONF-731218-P1, pp 259-269) IODINE TRAP TESTING IN NUCLEAR POWER STATIONS. Sigli, P.; Trehen, L. (CEA, Fontenay-aux-Roses, France). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

A description is given of the technique used for testing iodine traps. Labelled iodine 151 and methyl-iodide can be injected upstream of the trap in the piping system where the pressure is less than 1.4 bar. Samples on standard elements are taken upstream and downstream of the activated charcoal trap. The efficiency is evaluated by measuring the trapped activities. The sampling method allows comparison of the overall efficiency of the trap with that of a bed of the same kind and the same thickness, operating under the same conditions (relative humidity, temperature) as the trap itself. (auth)

5684 (CONF-731218-P1, pp 271-313) TESTING METHODS FOR IODINE FILTERS OF NUCLEAR PLANTS. Messore, G. (CNEN, Rome); Fiorentino, N.; Malossi, S.; Lanza, S.; Mazzini, M. Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

A discussion is presented of the characteristics of the various methods for testing the efficiency of filters and ventilation systems used in nuclear plants for the retention of iodine and its volatile compounds. A detailed report is given on the development of the equipment and instrumentation systems required for such tests, as well as on significant results pertinent to the qualification methods. Some tentative indications are given as to the criteria of choice among the various experimental methods in relation to the type of testing to be performed, suggesting some simple arrangements which could considerably facilitate the execution of periodical in situ efficiency tests of iodine filtering systems. (auth)

5685 (CONF-731218-P1, pp 329-351) IODINE FILTER TESTING IN SWEDEN. Hesbol, R.; Normann, B.; Devell, L. (Aktiebolaget Atomenergi, Studsvik, Sweden). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Charcoals and filters used for iodine removal in off-gases and ventilation ducts in nuclear power plants and a hot cells laboratory are tested in laboratory and in-situ to investigate and check the proper behavior of installed filter systems. In normal procedures of testing only methyl iodine is used due to more critical removal properties for this compound. The need for careful installation of filters and preoperational and periodical testing is illustrated. The poisoning of charcoal by impurities in the air has been studied and some results are given. (auth)

5686 (CONF-731218-P1, pp 353-360) FILTER TESTING FACILITY IN KARLSRUHE. Dillmann, H. G.; Bruederle, F.; Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

As part of its filters program, the Gesellschaft für Kernforschung has constructed a facility for testing air filters and off-gas filters used in nuclear plants. The lay-out of the rig is designed in accordance with the expected off-gas and air conditions in existing and planned nuclear power stations, and the air quality in containment buildings following accidents. The temperature, pressure, and gas composition can be varied in both fresh-air and closed cycle operation. The atmospheric humidity can be adjusted between 30 and 100% RH, and saturated steam and super-heated steam operation are also possible. The filter testing rig is fitted with all necessary auxiliary equipment such as steam generator, refrigeration machine, and water softener. The instrumentation enables temperature, pressure, differential pressure, humidity, and flow rate to be measured at several points of the circuit. The major measuring problem is the measurement of humidity. The infrared absorption of the water vapor is measured using a new, specially developed device for measuring humidity in gases. Account must be taken of the pressure dependence of the reading and the measuring range over approx. 3 orders of magnitude. First operating experience suggests that the required operating conditions and tolerances will be achieved, so that aerosol filter units and gas-sorption units can be tested under reactor operating conditions. (auth)

5687 (CONF-731218-P1, pp 361-390) EXPERIENCE AT WINDSCALE OF FULL SCALE IODINE SORPTION PLANT TESTING WITH METHYL IODIDE. Hillary, J. J.; Taylor, L. R. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

For a number of years the charcoal bed units of the Iodine sorption plants at Windscale have been tested with a realistic compound of fission product iodine, methyl iodide-131. The plants have included a range of design features and have been installed to perform a variety of duties, namely the control of

reactor coolant gas discharge, leakage, and hot cell ventilation. This full-scale test experience, combined with supporting laboratory tests on the sorption material (principally impregnated charcoal) also using methyl iodide-131, has sometimes revealed deficiencies in plant performance. Problems of mechanical bypassing of the charcoal and in one case extensive poisoning have been observed. Rectification measures and further testing were required to prove the satisfactory performance of the plant. By the application of proper safety procedures many tests have been conducted with millicurie levels of iodine-131 activity without causing safety problems. It is concluded that it is essential to carry out full-scale and laboratory testing of iodine sorption plant in order to give confidence in operational performance. Efficient operation also requires careful attention to design specification, which has been improved during the test program, and to supervision during plant installation. (auth)

5688 (CONF-731218-P1, pp 415-429) IODINE TRAPPING PLANT TESTING AT THE NUCLEAR POWER STATIONS OF ELECTRICITE DE FRANCE. Gence, M. (Electricite de France, Paris). Mar 1974. (In French).

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Off-gas systems in nuclear power stations are presently fitted with iodine traps making use of non-impregnated activated charcoal. This equipment is quite satisfactory for retention of molecular iodine but as recent experience tends to prove that most iodine present is to be found in the form of organic iodides, there are plans to replace the charcoal with new charges impregnated with potassium iodide. Owing to loss of efficiency with time, periodic controls are necessary. These can either be carried out in-situ on the entire unit or in the laboratory by quantitative analysis of a charcoal sample taken from the charcoal bed or from a reference trap connected in parallel. The controls carried out in nuclear power stations are based on both of these methods; in-place testing allows the entire trap (charcoal and filters, etc) to be tested under normal operating conditions. Results obtained show that filtering efficiency decreases with time, though charcoal ageing is not always the only factor responsible. The off-gas systems used are fitted with permanent intake orifices, which must respond to specific conditions if representative results are to be obtained. It has not always been possible to combine all requirements in current designs of ventilation systems, where the controls must include the filters and prefilters connected to the trap, and where the straight sections are not long enough to ensure proper homogenization of the trace. The test requirements should therefore be borne in mind at the design stage of the installation. (auth)

5689 (CONF-731218-P1, 431-463) OPERATING EXPERIENCE WITH IODINE FILTERING SYSTEMS IN ITALIAN NUCLEAR POWER PLANTS. Messore, G. (CNEN, Rome); Fiorentino, N.; Malossi, S.; Sacco, G. Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

A survey is presented of the various tests performed on the iodine filtering systems of the Latina and Trino Vercellese nuclear power stations. The methods used, the results and practical difficulties encountered are illustrated, as well as the way in which this experience has been used to improve gradually the test equipment and test procedures from the time of initial plant start-up. (auth)

5690 (CONF-731218-P1, pp 465-481) RESULTS AND INFORMATION OBTAINED FROM TESTS ON IODINE FILTERS. Wilhelm, J. G.; Gerlach, K. (Kernforschungszentrum, Karlsruhe, Ger.). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F. R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

Results are given of laboratory tests on batches of impregnated activated charcoal under simulated accident conditions, and of in-situ tests on iodine filters equipped with charges of this activated charcoal. Some measurements showed that the rate of retention had fallen considerably due to poisoning and ageing of the activated charcoal. For this reason specific tests were carried out to determine the service life of impregnated charcoal. An account is given of these tests. (auth)

5691 (CONF-731218-P1, pp 511-521) REGULATORY CONTROLS APPLIED TO IODINE TRAPPING PLANTS IN UK NUCLEAR INSTALLATIONS. Wright, H. A. (Dept. of Trade and Industry, London). Mar 1974.

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

The principal acts which control environmental aspects of nuclear power, the governmental departments, and regulatory agencies involved are briefly described. The requirements for iodine absorber plants and the controls applied to the design, construction, commissioning, operation, maintenance, and testing of such plants are outlined, and the role of the regulatory agencies is discussed. (auth)

5692 (CONF-731218-P1, pp 523-546) LICENSING ASPECTS OF IODINE TRAPPING DURING NORMAL OPERATION AND IN CASE OF ACCIDENTS. Franzen, L. F. (Technische Ueberwachungsvereine eV, Cologne). Mar 1974. (In German).

From seminar on the testing of iodine filters; Karlsruhe, F.R. Germany (4 Dec 1973).

In seminar on iodine filter testing.

In the assessment and licensing reports for the earliest German nuclear power stations iodine was already recognized as a fission product of the greatest biological importance and therefore monitored from its production to its release. Initial knowledge about quantities, concentrations, and composition of iodine was insufficient, and only improved in the course of time. It became apparent that the ventilation system rather than the gas exhaust system should be regarded as the main source of iodine release in normal working conditions. Leakages from the primary system resulted in varying amounts of iodine releases according to the ventilation principle applied (open or closed circuit ventilation system). Efforts to reduce iodine releases led in time to the installation of activated charcoal filters in the most widely varying ventilation systems, and to fuller and more precise design specifications. A similar development appears in connection with considerations related to appropriate accident analyses of specific reactor types. For reprocessing plants there actually exist only regulations for a pilot-plant. The fact that so few measurements have been made makes an appropriate research program a matter of urgency, as has been recognized from experience in the United States. Standardization of requirements in technical safety regulations has only just begun. (auth)

5693 (DEU-74-5) APPLICATION OF LEWATIT-ION EXCHANGERS AND LEWASORB-POWDER RESINS IN NUCLEAR REACTOR PLANTS. (Farbenfabriken Bayer A. G., Leverkusen (F. R. Germany); Zentralstelle fuer Atomkerenergie-Dokumentation, Leopoldshafen (F. R. Germany)). Mar 1971. 7p. (In German). INIS.

The treatment of make-up water is briefly mentioned, the purification of the reactor water, of the primary circuit water as well as of the secondary circuit, the condensate treatment, the waste water purification in the nuclear power plant or at reactor stations and the cleaning of the cooling pond are dealt with. (GE)

5694 (PB-224698) JOINT INDUSTRY/UTILITY PROGRAM TO DEVELOP NDT TECHNIQUES FOR NUCLEAR REACTOR INSPECTION: ADDENDUM REPORT. Final Report, 1 July–1 November 1972. Buck, J. S.; Graham, L. J.; Chretien, N.; Bell, R. I.; Collins, H. D. (Southwest Research Inst., San Antonio, Tex. (USA)). 21 May 1973. 182p. NTIS $5.25.

The work performed at the EEI/TVA nondestructive test method evaluation facility, located at the National Reactor Test Site, Idaho Falls, Idaho, July through October 1972 is summarized. The facility used was the experimental beryllium oxide reactor (EBOR). The major objective of the test program was to monitor flaw growth in the reactor pressure vessel with simulated plant noise and environment using prototype acoustic emission and acoustic holographic systems and conventional nondestructive inspection techniques. (auth)

5695 (TNO-LMEC-3) DEPARTMENT FOR OPERATION OF 50 MW TEST LOOP. Monthly Report, March 1974 (Weeks 10–13). (Nijverheidsorganisatie TNO, Hengelo (Netherlands). Centraal Technische Instituut). 1974. Translated from Dutch. 20p. Dep. NTIS $4.00.

Work performed under United States–TNO Technical Exchange Program.

The first half of this period was devoted to preparing steam generators E 201 and E 202 for resumption of operation. The blowdown system and the H_2 detection units were also modified. The evacuation of H_2 from cold trap E 103 was continued and completed during this period. The main burner of F 101 C was removed and inspected. The repairs will be carried out during the summer shutdown. After a continuous round-the-clock system of operation had commenced on March 14, 1974, the sodium system was filled again on March 16 and the thermal coupling resumed on March 26. The conditions of the steam generators (P and T) were brought to the nominal values in steps; the maximum power drawn off by the end of this period was 25 MW. (auth)

5696 (TNO-LMEC-4) DEPARTMENT FOR OPERATION OF 50 MW TEST LOOP. Monthly Report, April 1974 (Weeks 14–17). (Nijverheidsorganisatie TNO, Hengelo (Netherlands). Centraal Technische Instituut). 1974. Translated from Dutch. 24p. Dep. NTIS $4.25.

Work performed under United States–TNO Technical Exchange Program.

The installation was in operation throughout this period. An availability of 75% was obtained with the testing of the steam generators over this period. The steam/feed water system was out of operation for a few days for the fitting of an anti-frost device for the condenser plant and the execution of some repairs. (auth)

5697 (TNO-LMEC-5) DEPARTMENT FOR OPERATION OF 50 MW TEST LOOP. Monthly Report, May 1974 (Weeks 18–22). (Nijverheidsorganisatie TNO, Hengelo (Netherlands). Centraal Technische Instituut). 1974. Translated from Dutch. 26p. Dep. NTIS $4.50.

Work performed under United States–TNO Technical Exchange Program.

The installation was in operation throughout the period of the report. The availability of thermally coupled operation was 76.5%. In addition to long-term testing of the IHX and steam generators, the main attention was devoted to stability studies on the evaporator, the OVO being bypassed on the steam side. The low-load behavior of the steam generators and the installation was also investigated. Startup of the steam generators was carried out in accordance with a procedure drawn up by IA, but not at the accelerated rate, which is to be done in a subsequent period. A start was made on testing valve A 001; the leak test was performed several times, after which the valve was subjected to long-term testing under flow. During this period the sodium system was purified using the test cold trap E 106. Steady-state measurements were made on the newly instrumented mixing section MT 104. (auth)

5698 LEAK UNDERSTOOD. Bloomer, R. N. (Central Electricity Generating Board, Southampton, Eng.). Vacuum; 25: No. 2, 65-69(Feb 1975).

Surprising differences between leaks with laminar flow in nuclear boilers on-load, and off-load as measured by mass spectrometer, can be understood from a crack model with widths changed by hoop-stress. The bore of the tube in the leaking section of the boiler can be found from through-puts at two different pressure differences. The best pressure difference for off-load testing is deduced. As aids before and in off-loads searches, a simple vacuum bubbler and a pneumatically boosted water manometer are shown to have quantitative advantages. Laboratory tests confirm the crack model. (auth)

5699 ELECTRONIC DIGITAL CLOCK USING INTEGRATED CIRCUITS FOR THE DATA LOGGER SCANNER AND RECORDING A ANNUNCIATOR SYSTEM OF A NUCLEAR POWER REACTOR. Ambati, S. (Aston Univ., Birmingham, Eng.). Int. J. Electron.; 38: No. 2, 177-196(Feb 1975).

The development of a specialized electronic digital clock using integrated circuits for the data logger scanner and recording annunciator system of a nuclear reactor is described. The clock is built up in such a way that it can be used as a centralized clock for both the systems. It also gives simultaneously a time-display and a time-printout. It is also provided with many other facilities in order that it is suitable for data logger scanner and recording annunciator systems. Since the clock is constructed with integrated circuits, it is small in size, rugged and more reliable. Another important feature of this clock is that the whole circuit is printed. No external connecting wires or jumpers are used since double-side printing is provided. The printing has been done on a fibre glass material by the photo-etching contact type process. (auth)

5700 STANDPIPE ARRAYS. Hyde, J. E.; Williams, M. R. L. (to British Nuclear Design and Construction Ltd.). British Patent 1,374,482/B/. 20 Nov 1974. Filed date 5 Feb 1971. 6p.

A standpipe arrangement is described for a nuclear reactor having a core composed of substantially parallel moderator columns some or all of which contain fuel. A fuelling standpipe is provided for groups of such columns, together with one or more control rod standpipes located adjacent to the fuelling standpipes. The fuelling standpipe is large enough to allow passage of the fuel columns. Preferably the groups of columns comprise a central column closely surrounded symmetrically by six other columns; and the fuelling standpipe is aligned with the central column. Three control rod standpipes may be located around the fuelling standpipes so as to serve alternative columns, and a further three standpipes may be located around the fuelling standpipe for the control rods, or other control materials. To enable the upper end of a fuelling standpipe to be embraced by, and latched to, a fuel handling nose unit the control rod standpipes may be cranked or offset outwardly with respect to the fuelling standpipes at or near their upper ends. Alternatively the control rod standpipes may be inclined outwardly from their lower ends so as to diverge away from the fuelling standpipes at the upper end. (UK)

5701 METHOD AND APPARATUS FOR DISSIPATING KINETIC ENERGY. Behennah, F. E.; Preston, W. N. (to Flight Refuelling Ltd.). British Patent 1,371,331/B/. 23 Oct 1974. Filed Date 24 Aug 1970. 3p.

A description is given of a method of dissipating the kinetic energy of a load by means of a predetermined tube collapse pattern. An evisaged application is in the protection of nuclear fuel elements and the structure of the reactor core in the event of a failure of the loading gear. (UK)

5702 DYNAMIC STABILITY OF STEAM–WATER MIXTURE FLOW IN A ONCE-THROUGH STEAM GENERATOR FOR NUCLEAR POWER STATIONS. Polak, V. Jad. Energ.; 21: No. 3, 81-85(Mar 1975). (In Czech).

A mathematical model for the investigation of two—phase flow oscillations in a once-through steam generator of a nuclear power station was developed. The model is linearized and it uses the homogeneous flow model in a channel. Two methods of the system stability identification developed in the programming form are given. The influence of system parameters on the flow stability was investigated. The possibility to determine the contribution of various terms of characteristic equation on the stability is shown. The calculated and measured values of oscillation periods on the onset of instability for the once-through and recirculation system are in good agreement. (15 references) (auth)

5703 WELDING IN NUCLEAR ENERGY. Nucl. Eng. Int.; 20: No. 224, 56-59(Jan 1975).

From 2nd international colloguy on welding in nuclear engineering; Duesseldorf, Ger. (23 Oct 1974).

A review is presented of the work reported at the second international colloguy on welding in nuclear engineering held at Düsseldorf in October 1974. One of the major topics was underclad cracking. Following some general comments on the subject, highlights are given from some of the papers. These fell into two distinct categories concerned either with the mechanism of underclad cracking, or with methods of avoiding underclad cracking and porosity. Some interesting methods for remote plugging of steam generator tubes were also discussed. (UK)

5704 DEVELOPING LAMINAR RADIAL VELOCITY PROFILES AND PRESSURE DROP IN THE ENTRANCE REGION OF CONCENTRIC ANNULI. Coney, J. E. R. (Leeds Univ., Eng.); El-Shaarawi, M. A. I. Nucl. Sci. Eng.; 57: No. 2, 169-174(Jun 1975).

An analysis of the hydraulic entry-length problem in concentric annuli has been made by the linearized finite-difference method and the results are reported. Fifteen annuli of radii varying in ratio between 0.05 and 0.955 were investigated and typical radial velocity profiles at various axial distances from the annulus entrance are presented. A means for determining the pressure drop in the entry region is included. In the course of the study the developing axial profiles were observed to be in agreement with results in the literature. (auth)

Reactor Fuels

Refer also to abstracts 3151, 3157, 3161–3164, and 3901.

5705 (BARC/I-251) COMPATIBILITY OF AUSTENITIC STAINLESS STEELS WITH CERAMIC FUELS. Patil, R. V. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 14p. INIS.

The work on the compatibility of the ceramic fuels, like UO_2, UC, UN and also the (U, Pu) mixed oxide, carbide and nitride-fuels of different stoichiometric compositions with austenitic stainless steels has been reviewed. It is found that the stoichiometry of the fuel plays an important role in these compatibility reactions. The work on the effect of sodium environment on the compatibility of these fuel-clad combinations is also reviewed. (auth)

5706 (BARC/I-274) DETERMINATION OF TOTAL HYDROGEN CONTENT OF THE INSIDE SURFACES OF THE FUEL ELEMENTS AND IN THE COVER GAS. Srivastava, O. P.; Venkateswarlu, C. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 8p. INIS.

The zircaloy sheath of a fuel element maintained at 150°C was punctured under vacuum. The gases released from inside the element were collected and circulated over hot uranium (1000°C).

Hydrogeneous compounds decomposed giving hydrogen in the elemental state. The gas mixture thus obtained was analyzed chromatographically for the hydrogen gas content. As low as 1 μg of hydrogen can be determined. (auth)

5707 (NEDO-12440) IN-REACTOR DENSIFICATION BEHAVIOR OF UO_2. Marlowe, M. O. (General Electric Co., Pleasanton, Calif. (USA). Vallecitos Nuclear Center). Jul 1973. 31p. General Electric Co., San Jose, CA 95114.

The processes leading to the densification of porous nuclear fuels during irradiation are reviewed. It is concluded irradiation-induced diffusion plays a dominant role, i.e., the kinetics of densification can be no faster than diffusion will allow. Models for densification controlled by volume diffusion are modified to use irradiation-induced diffusion as the material transport mechanism. An experiment to determine the irradiation-induced diffusion in uranium dioxide is reviewed. The model and measured diffusivity are applied to the prediction of the densification behavior of uranium dioxide based on typical grain growth and densification rates. The heat-treatment conditions (time-temperature) for thermal simulation of a specific irradiation exposure in terms of fuel densification are estimated. Specific microstructural features leading to densification resistance are discussed. (auth)

5708 FISSION PRODUCT RETAINING NUCLEAR REACTOR FUEL. Steemers, T. C. (to United Kingdom Atomic Energy Authority). British Patent 1,371,699/B/. 23 Oct 1974. Filed date 18 Feb 1972. 3p.

Reference is made to coated particle nuclear fuels. When the particles are in oxide form, O_2 is liberated on fission, and residual O_2 that does not combine with fission products is available to react with the coating material, and a gas phase is formed that can build up damaging internal pressures. Incorporation of an oxygen getter is proposed, and in the scheme described the kernel contains, in addition to the fissile oxide, an oxide such as La_2O_3. The particles are manufactured in such a way as to inhibit formation of solid solutions of the oxides, or to prevent premature oxidation of any solid solution formed. The fissile oxide may envelop an inner "seed" of the non-fissile oxide, or alternatively the two oxides may be distributed homogeneously throughout the kernel. In order to avoid premature oxidation of the kernels they must be protected from an oxidizing atmosphere until coated with fission product retaining material. Possible substitutes for La_2O_3 are Y_2O_3, Nd_2O_3, Pm_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, and Lu_2O_3. These oxides have an anion vacancy structure, easily filled by oxygen. Methods of manufacture of the fuel particles are described. (UK)

5709 NUCLEAR FUEL COMPACT. Sturge, D. W. J.; Voice, E. H. (to United Kingdom Atomic Energy Authority). British Patent 1,376,365. 4 Dec 1974. Filed Date 8 Mar 1972. 3p.

An improved method of manufacturing coated particle nuclear fuel compacts is claimed. It comprises coating kernels of fuel with fission product retaining material, such as pyrolytic C or SiC, overcoating the particles with a matrix material consisting of graphite powder, an inert granular filler and a binder, and consolidating the particles to form a coherent compact. The filler material may be SiC or ZrO_2, and the binder may be a synthetic rain. (UK)

5710 PECHINEY UGINE KOHLMANN. From Uranium Prospecting to Fuel Fabrication. Nucl. Eng. Int.; 20: No. 224, 31-37 (Jan 1975).

The activities of the Pechiney Ugine Kuhlmann group, particularly those concerned with the nuclear fuel cycle, are examined. The group structure, activities, and relations with other companies and organizations are shown. Plants and processes used for U concentration, UF_6 conversions, enrichment, and fuel element fabrication are discussed. The production of zirconium and other special nuclear materials is also considered. (UK)

5711 NUCLEAR FUEL BUNDLING SYSTEM. Cracknell, A. G.; Boardman, J. (to Canadian General Electric Co. Ltd.). Canadian Patent 963,185. 18 Feb 1975. vp.

The present invention provides a tie ring construction for restraining the individual rods of a fuel bundle against radial distortion. (auth)

5712 IMPROVEMENTS IN THERMAL ENERGY HIGH POWER ELECTRICAL ENERGY CONVERTERS. Lalaurie, J. (to Thomson-CSF). French Patent 2,177,525. 28 Mar 1972. 14p. (In French).

The thermal energy to electrical energy converter comprises several series-mounted converter members. All these converter members are located in the same tight enclosure, thus with as few brazed connections and insulating ceramics as possible. The emitter of one of these members and the collector of the next member form but one metal part comprising two hollow cylindrical portions, one of which is inserted into the other so as to form a converter member which is heated by a nuclear fuel rod. One of pair of independent circuits is used for circulating cesium vapors between the electrodes and the other for pumping the fission products. (FR)

5713 PLUTONIUM AND RECYCLE. Nucleonics Week Special Report. New York; McGraw-Hill, Inc. (1974). 9p.

News items selected from Nucleonics Week concerning plutonium and plutonium recycle are presented. (JWR)

5714 EFFECTS OF TEMPERATURE DISTRIBUTION ON SWELLING OF UO_2-PuO_2 FUEL CORES. Kuz'min, V. I.; Lebedev, I. G. At. Energ. (USSR); 38: No. 1, 11-15(Jan 1975). (In Russian).

The object of this work was to study the temperature dependence of gas swelling of oxide fuel. The porosity distribution in UO_2 and UO_2-PuO_2 fuel element cores irradiated in the burnup range of 0.4-17% of heavy atoms and at linear power of 245-510 W/cm was studied by means of quantitative metallography. In the 1000-1500°C region of a fuel core gas swelling increases linearly with burnup, while in the region above 1500°C gas swelling reaches saturation at about 1% burnup. A qualitative description of the mechanisms of gas release and swelling of oxide fuel in the temperature range of 1000-2500°C is given. An empirical zone model for the calculation of volume changes in fuel element cores taking into account initial porosity, burnup and temperature distribution is proposed. It is shown that increasing the initial porosity of fuel pellets and linear power results in reduced fuel swelling. 10 references. (auth)

5715 IAMBUS-1: A DIGITAL COMPUTER CODE FOR THE DESIGN, IN-PILE PERFORMANCE PREDICTION AND POST-IRRADIATION ANALYSIS OF ARBITRARY FUEL RODS. I. Theory and Modelling. Wordsworth, J. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bensberg; Koeln (F. R. Germany)). Nucl. Eng. Des.; 31: No. 3, 309-336(1974).

The multi-zone code IAMBUS is built around a sound but flexible mechanical analysis of fuel and cladding. A state of generalized plane strain approximates the cladding; the fuel is modelled by a state of plane stress, a state of generalized plane strain, or a combination of these two well-known stress-strain configurations depending on the macroscopic structure of the fuel prevailing. It is thus possible to follow closely the deformation of the fuel and cladding as these are subjected to varying (in part mutual) loads, beginning with a relatively loose, somewhat random assemblage of minute fuel fragments at BOL and progressing to a quasi compact continuum of fuel at EOL. Cladding analysis includes routines for plasticity, creep and swelling due to void nucleation and growth; in the fuel restructuring, plasticity, creep, swelling due to solid and gaseous fission products, fission-gas release and internal pressure build-up are modelled. Routines for friction and heat transfer between fuel and cladding are also incorporated. No strict temperature-dependent boundary is drawn between typically elastic and plastic behavior, the multi-zone nature of the code models the gradual transition between these two types of material behavior observed in practice with increasing temperature. Great care has been exercised in choosing numerical methods, since the most sophisticated/realistic modelling is of limited value if the effort expended in reaching a numerical solution becomes exorbitant. Multi-zone modelling lends itself readily to the method of finite differences. The finite difference equations are solved via the method of secants, modified to guarantee convergence for all IAMBUS functions in a feasible amount of computer time. (auth)

Reactor Control Systems

5716 (RLO)-75-1) SNEAK CIRCUIT ANALYSIS OF N REACTOR. Final Report. Brown, W. S.; Alexander, R. G. (Boeing Aerospace Co., Houston, Tex. (USA)). 31 Jul 1974. 110p. Dep. NTIS $8.50.

A description is given of analysis of N Reactor instrumentation and control circuits which was performed to identify latent circuit defects and potentially troublesome failure points. (DG)

5717 (TID/SNA-1741) ANALYSIS AND DESIGN OF THE NERVA ENGINE CONTROL SYSTEM. Parziale, E. A.; Porcelli, G. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 17 Aug 1970. 20p. Dep. NTIS $4.00.

In the analysis and design of large nonlinear systems it is general practice to linearize the equations to form a system model valid near an operating point. This allows much more ease and flexibility in analytical work and in many cases is the only means for handling large complex systems. By ap-

propriately dividing the operating region into segments, each having a model, linear system theory may be applied in a piecewise manner and the results later combined. Linearization of the Smith-Stenning nuclear engine model is described in detail. It is shown how the static equations, which express the steady-state relationships among the variables of the original nonlinear system at an operating point, along with the small signal equations, are obtained in the process of linearization. (auth)

5718 (TID/SNA-1742) MULTIVARIABLE CONTROLLER DESIGN PROCESS. Dowling, E. F. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 23 Apr 1971. 66p. Dep. NTIS $6.50.

The present NERVA engine is a highly cross-coupled system in that all of the control inputs have a strong effect on all the controlled variables. This cross-coupled nature makes the design of controls on the basis of multiple loops, each loop using one control input to control one engine variable, an undesirable, iterative process. Multivariable control design, based on use of state variable feedback, provides a desirable, one pass design process. Inclusion of a digital computer within the control system provides a compact, flexible means of implementing multivariable control. Techniques have been developed to produce a multivariable controller for the NERVA engine. These techniques emphasize automation of the procedure through use of digital computer programs wherever possible. The design procedure has three main divisions, system modeling, controller design, and controller simulation and checkout. System models are produced from the reference model (E-1 CAM) which are linear and low order. These models are used to calculate the feedback matrix using a quadratic optimization technique. Results of engine controllability studies are used to design nominal actuator profiles and the corresponding state reference trajectories. State estimation is provided through use of specific E-1 CAM equations. For design work to date, requirements for a supervisor function have been minimal. However, this function will assume greater importance when controls for different engine operating modes and regions are integrated. The controller elements, demand generator, feedback matrix, and state estimator are mechanized with the E-1 CAM on the hybrid computer and the performance of the controlled system is evaluated against control requirements. Information from the controller evaluation is fed back to modify and improve the controller design. (auth)

5719 (TID/SNA-1744) LOCATION OF NERVA INSTRUMENTATION AND CONTROL COMPONENTS. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 64p. Dep. NTIS $6.25.

There are five functional electronics blocks which comprise the I & C system. They are interconnected among themselves, to the stage and to the engine by the sixth functional unit, the wiring harness. The function of these blocks is as follows: Data Acquisition System, Data Control Unit, Power Distribution Unit, Actuator Drivers, Control Computer, and Wiring Harness. It was concluded that although the minimum risk approach was to put all electronics on the run tank top that for only a moderate increase in risk all the electronics should be mounted in the vicinity of Station 0.0. This is potentially the lowest weight system and the range of uncertainty in predicting the advancement of the state-of-the-art in rad hardened electronics is less than for any of the other configurations. It is concluded that configuration represents the best compromise between reliability difficulties and weight penalties. (auth)

5720 (TID/SNA-1750) HIGHLIGHTS OF PERTINENT NERVA I AND C DOCUMENTS. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 1972. 10p. Dep. NTIS $4.00.

The computer requirements and the related instrumentation and control equipment, software, etc., with which it must be interfaced are reviewed and brought up-to-date by summarizing the information in 26 reports. A tentative recommendation is made for an extended Fortran language to code control software in a modified computer. The choice of a computer was based on the family computer concept and the uses foreseen (design, controls design and analysis, reactor and engine test software and flight engine software). Tentatively, the Systems Engineering Lab, Model 86/88 computer family was selected. There is a brief discussion of engine sensors, data acquisition systems, data control units, control, stage/vehicle/engine interface unit, actuator drivers, power distribution unit, instrumentation and controls (weight and volume), software and the relations between these items. The location of electronic equipment is considered from the points of view of heat, radiation, weight, volume, harness, interfacing problems, safety, reliability, etc. (LTN)

5721 (WANL-TME-734) STABILITY OF THE NRX-A2 REACTOR CONTROL SYSTEM AT LOW POWER AND SHORT PERIODS. Hafer, J. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Apr 1964. 18p. Dep. NTIS $4.00.

Declassified 11 Sep 1973.

An analysis was performed to determine the effect of power level, detector position, and reactor period upon the stability of the NRX-A2 reactor-control loop in the subpower range. It was found that the loop tends to become more unstable as the reactor period and the reactor power level are reduced. The stable and unstable operating regimes of the NRX-A2 reactor in the subpower range were determined for asymptotic reactor periods ranging from 0.3 second to infinity. It was also established that the reactor control loop is unstable at all power levels for reactor periods of 0.2 second or shorter. Operating restrictions and recommendations for further work are given. (auth)

5722 (WANL-TME-1024) FEASIBILITY OF USING CORE INLET PRESSURE AS A CONTROL VARIABLE FOR THE NERVA ENGINE. Buker, J. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 4 Nov 1964. 11p. Dep. NTIS $4.00.

A study was made on the analog computer to investigate the feasibility of using core inlet pressure as an engine control variable. The study basically consisted of determining the static and dynamic relation between core inlet and exit pressure using the revised analog core model. The feasibility was demonstrated by successfully replacing core exit pressure with core inlet pressure as the control variable in some analog-engine-model transients. Subject to physical limitations, the computer results generally indicate that it is analytically feasible to employ core inlet pressure as an engine control variable in the power range. (auth)

5723 (WANL-TME-1118) CONTROL TEMPERATURE ERROR ANALYSIS. Mackey, L.; Kirschbaum, H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 8 Mar 1965. 27p. Dep. NTIS $4.50.

Declassified 10 Sep 1973.

In-core thermocouple errors affected the control system during NRX-A2 tests and caused the reactor to be operated about 15% above planned power. The thermocouples have been modified to remove the cause of error but it is also recommended that thermocouples in other locations be used for core temperature control on the basis of a rather detailed analysis. (LTN)

5724 (WANL-TMI-1624) RELIABILITY ASPECTS OF CONTROL DRUM DRIVE SYSTEMS. Wagner, G. L.; Ottenheimer, F.; Starek, R. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 5 Jan 1966. 53p. Dep. NTIS $5.75.

A study comparing and discussing the reliability of two basic methods of driving control drum by means of pneumatic actuators is presented. Proposed variations in design of component parts are examined. Recommendations and reservations are expounded. The conclusion is reached that a mechanically coupled system driven by three actuators is six times as reliable as the presently accepted system of individual actuators for all control drums. A more general conclusion from reliability trade off studies favors minimizing the number of actuators. This approach is recommended for larger systems, subject to the assurance of functional independence through the use of highly reliable decoupling and override features. (auth)

5725 (WANL-TNR-034) REACTOR CONTROL SYSTEM, NERVA PHASE I. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 25p. Dep. NTIS $4.25.

Declassified 10 Sep 1973.

The NERVA nuclear reactor will be controlled by a set of twelve cylindrical drums located symmetrically about the core. Each of the drums contains a segment of neutron absorbing material so that there is a change in reactivity as the drum positions are changed. A successful reactor control system must, therefore, control the position of the drums during the startup, steady state, and shutdown modes in such a manner as to achieve the desired response and to control the reactor power and temperature within prescribed limits. The following presentation first describes each of the modes in terms of the operating condition of the reactor, and then describes the proposed reactor control system and outlines the way in which this system functions to achieve correct control of operating conditions in each mode. The closing paragraphs outline major problem areas foreseen in reaching the requirements in each mode of reactor operation. (auth)

5726 (WANL-TNR-035) REACTOR CONTROL COMPONENTS. Phase I. NERVA Nuclear Subsystem. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1962. 65p. Dep. NTIS $6.25.

Declassified 10 Sep 1975.

The research, development, and testing activities that have been conducted on the NERVA reactor control system components during Phase I are described. The report is organized into four major sections: Neutron Detectors, Temperature Measurements in the Core of the NERVA Reactor, Radiation Resistant Circuits, and Amplifier and System Hardware Environmental Testing. Each section discusses the goals of the component development effort, problems and proposed solutions, progress accomplished, and plans for future work. (auth)

5727 (ZJE-154) KS-150 REACTOR CONTROL. Wagner, K. (Skoda, Plzen (Czechoslovakia)). 1974. 17p. Dep. NTIS (US Sales Only) $4.00.

The reactor control and protection system (SOR) includes detecting elements, transmission routes, evaluating instruments, power amplifiers, actuators and the corresponding measuring, logic and signalling circuitry for reactor period and power measurements, manual and automatic control, detection and evaluation of emergency conditions and execution of the necessary emergency intervention. In order to extend the automatic control range, the basic system (SOR) is supplemented with a mobile neutron detector system (PK). (auth)

5728 OSNOVY AVTOMATICHESKOGO UPRAVLENIYA YADERNYMI KOSMICHESKIMI ENERGETICHESKIMI USTANOVKAMI. (Principles of the Automatic Control of Nuclear Power Plants in Outer Space). Petrova, B. N. (ed.). Moscow; Mashinostroenie (1974). 379p.

The book is a generalization of theoretical studies in the area of the dynamics of space power installations and their control. The mathematical apparatus, methods, and algorithms for the study of the dynamics of the distributed systems as applied to space power installations are discussed. Approximation methods are given for the determination of the dynamic characteristics of heat-exchange apparatus and the basic elements of the installation. The control under normal and start-up operating conditions with direct conversion of the nuclear energy into electrical energy and with use of machine energy converters is examined. The problems of optimum control according to the installation are formulated and methods for their solution are given. (tr-auth)

5729 COMBINED SPACE-TIME EFFECTS OF XENON TRANSIENTS AND REACTOR CONTROL DURING LOAD FOLLOWING IN A PEBBLE-BED HIGH-TEMPERATURE REACTOR. Lauer, A.; Froehling, W. (Kernforschungsanlage Juelich G.m.b.H., Ger.). Nucl. Sci. Eng.; 57: No. 1, 28-38(May 1975).

Extending the previously presented steady-state characteristics of the pebble-bed high-temperature reactor with the new "once through then out" (OTTO) fuel concept, its load-following properties, i.e., the slow core transients in connection with adjustments of the reactor output to meet the power demand, are analyzed. Neutronic and thermodynamic characteristics of this strongly asymmetric core design during the related xenon transients are considered. The two-dimensional analysis considers the extremely space-dependent core conditions of a medium sized OTTO pebble-bed reactor during the transient, where the inhomogeneous xenon redistribution and a rod control acting only in the top reflector compete with each other to influence the axial power-density profile. The resulting variations in the maximum fuel temperatures are remarkably small, which reemphasizes the favorable thermodynamic properties of this new reactor concept. (auth)

5730 THE DYNAMICS AND CONTROL OF LARGE WATER REACTOR CORES. Lunde, J. E.; Versluis, R. M. (Regelungstechnik; 22: No. 12, 365-374(Dec 1974). (In German).

A description of basic physical problems of reactor dynamics and reactor control is given by this contribution. Especially the neutron physical and thermodynamic processes in the core of the reactor are discussed. The dynamic behavior of a nuclear reactor is determined by the interactions between nuclear and thermohydraulic subprocesses. The essential parameters for the automatic control system of the reactor comprise both measurable state variables and other derived quantities. In simplified concepts, a survey of the most important of those quantities and of the coupling mechanisms between them is presented. (GE)

5731 OPTIMIZATION OF CONTROL ROD CONFIGURATIONS FOR A SMALL LWR. Buenemann, D.; Siewers, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (F. R. Germany). Inst. fuer Physik). Atomkernenergie; 24: No. 4, 247-250(1974).

The German nuclear ship project NCS-80 is based on a small light water reactor of an integrated design (FDR-type) with a thermal power of 220 MW. For its reactor core a relatively small number of large fuel elements have been chosen for which the reactivity compensation has to be done partly by burnable poisons and partly by the movement of control rod banks. Since a high power density of the core is desirable a full optimization of the control rod bank configurations had to be performed in order to minimize the maximal form factors in the core. After a short description of the 3D-reactor simulator LEIWAR the methods and results of this optimization procedure are described and their applicability to other reactors is discussed. (auth)

Nuclear Power Plant Economics

5732 (AD-783796) ROLE OF NUCLEAR POWER IN ACHIEVING U. S. ENERGY SELF-SUFFICIENCY. Arnold, H. L. Jr. (Army War Coll., Carlisle Barracks, Pa. (USA)). 28 May 1974. 59p. NTIS $6.00.

The extent to which the nuclear power industry should be expected and encouraged to contribute to US energy self-sufficiency is investigated by quantifying the current and projected shortfall in domestic energy resource production and examining the potentials of the nuclear industry and all feasible alternatives in eliminating the shortfall. Current data establishing the shortfall through the end of this century are presented, as are summaries of the current status and expected future contributions of alternative solutions. (auth)

5733 (SAND-75-5004) DYNAMICS OF NUCLEAR REACTOR OPERATIONAL CYCLES. Chapman, L. D.; Wayland, J. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). [nd]. Contract AT(29-1)-789. 12p. (CONF-750418-2). Dep. NTIS $4.00.

From 6th annual conference on modeling and simulation; Pittsburgh, Pennsylvania, USA (24 Apr 1975).

With this system dynamics computer model, one can explore the long term effects of a nuclear reactor program. Given an input demand for reactors, the consequences on each sector and the interactions among sectors can be simulated to provide a better understanding of the time development of a nuclear reactor program. The model permits the determination of various levels of activity as a function of time for plant enrichment, fuel fabrication, fuel reprocessing and storage of waste products. In addition, the rates of construction of reactors, spent fuel transit, disposal of waste, mining, shipping, recycling and enrichment can be investigated for optimal planning purposes. The model has been written in a very general manner so that it can be used to simulate any nuclear reactor program. It is an easy task to relate the amount of accidental or operational release of radioactive contaminants into our environment to the activity levels of each of the above sectors. (auth)

5734 ELECTRICAL SUPPLY AND THE FUTURE. III. Reactor Technology. Carter, J. Architects' J.; 161: No. 7, 351-356(12 Feb 1975).

The technical difficulties which were experienced during the first and second programs of UK nuclear stations using Magnox and AGR type reactors are discussed. In the late '60s and early '70s five reactor types (HTR, SGHWR, FBR, LWR, and CANDU) were considered as possible candidates for the next step in UK power station design. Brief descriptions are given of each type. The technical and political disputes which occurred over the choice of reactor design are outlined. (UK)

5735 2,300 MW OFFSHORE NUCLEAR POWER PLANT PROJECT. Gitlevich, A. D. Ekspress-Inform., Stroit. Tepl. Elektrosta.; No. 4, 18-20(1973). (In Russian).

A project is described which considers the placement of an atomic power plant in the open sea on two floating platforms having dimensions of 122 × 166 m and a water displacement of 126,000 metric tons each. Each platform contains equipment for a 1150 MW power plant along with a transformer substation. The platforms are moored several kilometers from the shore, and are protected by a jetty. The substation is connected to the shore by an underwater cable. The protective reactor shell is designed with an ice condenser. Equipping of the units at shipyards will begin in the middle of 1975. Final installation of the atomic energy reactor in the sea is planned for 1980. The estimated price of the installation is one billion dollars including 250 million dollars for the jetty. The unique, obvious advantage for a nuclear reactor of this type is the elimination of the necessity of using a large land area. The creation of floating power reactors is linked with considerable difficulties. (tr-auth)

5736 INTERNATIONAL CAPITAL MARKET AS A SOURCE OF NUCLEAR FINANCE. Paxman, W. H. Nucl. Eng. Int.; 20: No. 226, 173-176(Mar 1975).

The magnitude of the capital requirements for financing programmes for development of the world's nuclear power, the fact

that no return on the investment is earned for many years and the long pay-back period make it inevitable that a large part of these requirements will have to be met by borrowing. The utilities carrying out the development would ideally wish to undertake all this borrowing in their own countries, to avoid incurring any exchange risk, and on terms which are tailored to the particular project for which the funds are raised. Domestic sources, however, are coming under increasing pressures and utilities now have to contemplate turning to international borrowing. The variety of sources and different forms of credit available still allow some scope for conditions to be chosen to suit the requirements of the project concerned. (auth)

5737 FINANCING NUCLEAR POWER FOR GERMANY. Roser, T. (Kerntechnische Gesellschaft im Deutschen Atomforum eV, Bonn). Nucl. Eng. Int.; 20: No. 226, 177-178(Mar 1975).

By 1985 nuclear power is expected to supply 15% of the German Federal Republic's energy needs and account for 45% of electricity generated. Raising the necessary finance will be difficult but not impossible, and there may be greater problems with public acceptance and waste disposal. Several proposals for meeting the nuclear industry's financial requirements are being examined. The ability of utilities to provide adequate funds from their own resources depends on whether they can charge proper economic prices for electricity. (auth)

5738 FINANCING NUCLEAR POWER IN JAPAN. Suetsuna, I. Nucl. Eng. Int.; 20: No. 226, 179-182(Mar 1975).

The financing of nuclear power in Japan at all stages from research and development through full-scale demonstration to commercial large scale power stations is described. Research and development is conducted, mainly by the three government agencies JAERI, PNC and JNSDA, each being almost completely government financed. The electric power companies' sources of finance are explained. Interest rates are discussed and an illustration is given of both short and long term syndicate loan agreements by government owned banks to an electric power company. Finally, methods of financing the current long-range program are discussed. (UK)

5739 FINANCING THE SPANISH NUCLEAR POWER PLANT PROGRAMME. De Cubas, J. (Kuhn-Loeb and Co., New York). Nucl. Eng. Int.; 20: No. 226, 182-183(Mar 1975).

Spain's nuclear power programme has been characterized by a close collaboration between several leading Spanish private utilities, U. S. manufacturers and the Export Import Bank of Washington. Interest is concentrated primarily on the role of the USA in financing part of the program. Some details are given of the Exim Bank loans for the Zorita station and for a typical station included in the second phase of the program. For the third phase, contracts are under consideration for a possible ten stations in the 1000 MW range. The financial problems involved and the options of the Spanish utilities and government in facing them are discussed. (UK)

5740 EFFECTS OF INFLATION AND RECESSION ON NUCLEAR PROJECT FINANCING IN THE USA. Katzin, J. S. (Kuhn-Loeb and Co., New York). Nucl. Eng. Int.; 20: No. 226, 184-186(Mar 1975).

The demand for nuclear power stations in the United States and the way they are financed must be seen in the context of a wide range of changes facing utilities. Inflation is the most critical of these and can make the longer lead time required in the U. S. for nuclear stations enormously expensive. One estimate puts the additional cost of the extra four years at $1186 million or an extra $5.6 mills/kWh over the life of the station. One result of the current pressures is to make utilities less hostile to public ownership. (auth)

5741 MEETING THE FINANCIAL NEEDS OF THE NUCLEAR POWER INDUSTRY. Slavich, D. M.; Snyder, C. W. Nucl. Eng. Int.; 20: No. 226, 161-164(Mar 1975).

After a brief look at the expected growth of nuclear power both in and outside the USA, capital cost of nuclear generating facilities and capital requirements for the development of nuclear power are discussed. The sources of finance for nuclear plants are considered and a hypothetical project analysis involving an 1100 MW plant is presented to illustrate the factors, economic and otherwise, affecting the financial assessment of a nuclear addition by a company. (UK)

5742 ENERGY FINANCE, NUCLEAR FINANCE, AND THE CAPITAL MARKETS. Silcock, J.; Heyman, T. Nucl. Eng. Int.; 20: No. 226, 170-173(Mar 1975).

World energy finance requirements, and the ways in which the capital markets in their current state of crisis can be expected to meet them are considered. The specific requirements of nuclear finance, the financing problems that are unique to nuclear energy, and ways in which they might be solved are discussed. (UK)

5743 WORLD NUCLEAR PROGRAMMES. Greenhalgh, G. (British Nuclear Forum, London). Nucl. Eng. Int.; 20: No. 226, 164-169(Mar 1975).

The recent oil crisis resulted in reappraisals in many countries of the role of nuclear power in the energy field. The achievements of the various types of reactor systems are discussed. Factors which could influence the extent of future nuclear programs such as capital cost of plant and availability of nuclear fuel services are considered. Some detailed programs are given for Europe, Japan and the U. S. A. (UK)

5744 DEVELOPING WORLD'S NEED FOR NUCLEAR [ENERGY]. Kovan, D. Nucl. Eng. Int.; 20: No. 224, 38-42 (Jan 1975).

A review is presented of the economic assessment of nuclear power in developing countries that was produced by the IAEA in their market survey of 1973 and updated in 1974. The scope and implementation of the original survey and its extension are described, and results are presented. Some of the assumptions made in the analysis, the methods of forecasting and of cost estimating are discussed. (UK).

5745 FUEL FOR THOUGHT. Hart, A. (Central Electricity Research Labs., Leatherhead, Eng.). Chem. Brit.; 11: No. 2, 55-59(Feb 1975).

It is stated that the increasing high cost of oil may mean that electro-chemical processes will play a major role in the future energy economics of advanced nations. As the fraction of nuclear based electric power increases, it could become attractive to store large quantities of electricity in electrochemical batteries. Later on electrochemical processes may assist in the transmission of nuclear energy by converting it into H_2 by electrolysis of water, and then making electricity available again in the home or factory by means of a H_2/air fuel cell. These possibilities are fully discussed in this paper. (UK)

5746 NUCLEAR ENERGY AND DEMOCRACY IN SWITZERLAND. Zangger, C. Int. At. Energy Agency Bull.; 16: No. 6, 8-18(Dec 1974).

A brief sketch of the growth of the nuclear power industry in Switzerland is presented. Various considerations involving safety, environmental effects, and economics of nuclear power are mentioned together with recommendations to insure that Swiss citizens be adequately informed so as to be able to contribute to a solution to the nuclear controversy. (DG)

5747 NUCLEAR HEAT FOR INDUSTRIAL PURPOSES AND DISTRICT HEATING. Int. At. Energy Agency Bull.; 16: No. 6, 33-37(Dec 1974).

From IAEA study group meeting; Vienna (Sept 1974).

Studies on the various possibilities for the application of heat from nuclear reactors in the form of district heat or process steam for industrial purposes had been made long before the present energy crisis. Although the studies have indicated technical feasibility and economical justification of such utilization, the availability of relatively cheap oil and difficulties in locating a nuclear heat source inside industrial areas did not stimulate much further development. Since the increase of oil prices, the interest in nuclear heat application is reawakened, and a number of new potential areas have been identified. It now seems generally recognized that the heat from nuclear reactors should play an important role in primary energy supply, not only for electricity production but also as direct heat. (auth)

5748 ENERGY SITUATION AND THE ROLE OF NUCLEAR POWER. Hill, J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Atom (London); No. 219, 2-7(Jan 1975).

A picture is attempted of the part that nuclear power should be able to play in the future overall energy scene in the UK and the world. Consideration is given to present problems and fears of the environmentalists and the reality or otherwise of these fears. It is concluded that there is a great future for nuclear power and, in spite of several false starts, a steady expansion has been launched. (UK)

5749 NUCLEAR FINANCING. Nucleonics Week Special Report. New York; McGraw-Hill, Inc. (1974). 7p.

News items selected from Nucleonics Week concerning nuclear financing are presented. (JWR)

5750 TOTAL ENERGY INVESTMENT IN NUCLEAR POWER PLANTS. Rombough, C. T.; Koen, B. V. (Univ. of Texas, Austin). Nucl. Technol.; 26: No. 1, 5-11(May 1975).

Studies have shown that the total energy required to construct a 1000-MW(e) nuclear power plant is about 4.1×10^3 kWh for light-

water reactors. This is equivalent to approximately 1.9 percent of the total energy produced by the plant (in the form of electricity) over a 30-yr life at an 80 percent load factor. An additional 3.4 x 10^8 kWh(e) of energy per year is used in maintaining the fuel cycle for a boiling-water reactor (BWR) and 3.6 x 10^8 kWh(e)/yr for a pressurized water reactor (PWR). This corresponds to 4.9 percent of the output electricity for a BWR and 5.2 percent for a PWR. The total investment in energy is, then, 6.8 percent for a BWR and 7.1 percent for a PWR. On a total system energy cost, nuclear plants are comparable to coal plants in that 7.8 percent of the plant energy is required for deep-mined coal and 6.7 percent for surface-mined coal. 22 references. (auth)

Reactor Fuel Cycle Economics

Refer also to abstracts 5325 and 5668.

5751 (CONF-750117-1) ECONOMIC INTERACTIONS BETWEEN FUELING, SEPARATIVE WORK AND CAPITAL REQUIREMENTS FOR FISSION POWER REACTORS. Kasten, P. R.; Bennett, L. L. (Oak Ridge National Lab., Tenn. (USA)). 1975. 36p. Dep. NTIS $5.00.

From international symposium on nuclear power technology and economics; Taipei, China, Mainland (13 Jan 1975).

Systems analyses of the economic interactions between fueling, separative work, and capital requirements for power reactors are reviewed. (JWR)

5752 LONG AND THE SHORT OF NUCLEAR FUEL FINANCE. Young, G. K. (Kleinwort Benson Ltd., London). Nucl. Eng. Int.; 20: No. 226, 186-188(Mar 1975).

The difficulty of long term costing is considered. The problem of escalation, the uncertainty of foreign exchange, and conflicting trends, national and international, in relation to nuclear fuel all underline the need to formulate a clear concept in planning finance for nuclear fuel supplies. The financing of enrichment services and reprocessing for future programmes is discussed. (UK)

Reactor Licensing and Regulation

5753 (DOCKET-50003-440) INDIAN POINT STATION, UNITS 1 AND 2. Semiannual Operating Report No. 24, July-December 1974. (Consolidated Edison Co. of New York, Inc., New York (USA)). 28 Feb 1975. 273p. Dep. NTIS $16.75. (DOCKET-50247-426)

Net electrical power generated by Unit 1 was 519,130 MWH with the reactor critical for 2,400.39 hours and the generator on line for 2,316.14 hours. Unit 2 generated 2,427,828 MWH electrical power, was critical for 3,590.31 hours and the generator was on line for 3,485.41 hours. Operations and maintenance are summarized. Information is presented concerning radioactive effluent releases, occupational personnel radiation protection, primary coolant chemistry, changes, tests, and experiments. Environmental radioactivity is discussed. (FS)

5754 (DOCKET-50146-126) SAXTON NUCLEAR EXPERIMENTAL REACTOR. Annual Report 1974 and Report on the Decommissioned Status of the Facility. (Saxton Nuclear Experimental Corp., Pa. (USA)). 20 Feb 1975. 18p. Dep. NTIS $4.00.

The decommissioned plant is described and the disposition of special nuclear materials, sources, and by-product materials is explained. Information is presented concerning the containment vessel, control and auxiliary buildings, the radioactive waste disposal facility, pipe tunnels, tanks, storage areas, miscellaneous areas, status of systems and components, and the refueling water storage tank. An inventory of radioactive materials left on the site is given. (FS)

5755 (DOCKET-50280-312) SURRY POWER STATION, UNITS 1 AND 2. Semiannual Operating Report, July-December 1974. (Virginia Electric and Power Co., Richmond (USA)). 1974. 546p. (DOCKET-50281-301). Dep. NTIS $30.50.

Net electric power generated by Surry Unit 1 was 6,930,353 MWH with the generator on line for 10,417.7 hours. Net electric power generated by Unit 2 was 5,699,299 MWH with the generator on line for 8,384.2 hours. Information is presented concerning operation, radioactive effluent releases, solid radioactive wastes, fuel shipments, occurrences in which temperature limitations on the condenser cooling water discharge were exceeded, changes in station organization, occupational personnel radiation exposure, nonradiological monitoring including thermal, physical, and biological programs, and the radiological environmental monitoring program. (FS)

5756 (DOCKET-50293-410) PILGRIM NUCLEAR POWER STATION, UNIT 1. Fifth Semiannual Operating and Maintenance Report, July-December 1974. (Boston Edison Co., Mass. (USA)). 1974. 55p. Dep. NTIS $5.75.

During this period the reactor was critical for 3,550.3 hrs and the net electrical power generated was 1,973,033 MWH. Information is presented concerning operations, maintenance, radioactive effluents, environmental monitoring, and radioactive materials released to unrestricted areas. (FS)

5757 (DOCKET-50331-392) DUANE ARNOLD ENERGY CENTER. Semiannual Operation Report (Revision 1), July-December 1974. (Iowa Electric Light and Power Co., Cedar Rapids (USA)). 6 Mar 1975. 299p. Dep. NTIS $18.00.

The start-up testing program was in progress, but net electrical power generated was 1,320,654 MWH. The unit was critical for 3620.2 hours and the generator was on line for 3389.7 hours. Information is presented concerning operations, power generation, shutdowns, maintenance, changes, tests, experiments, primary coolant chemistry, and occupational personnel radiation exposure. Radioactive effluent, radiological monitoring, nonradiological monitoring, and environmental monitoring are described. (FS)

5758 (FIND-STN-50495) FIND: PRESSURIZED WATER REACTOR REFERENCE NUCLEAR POWER PLANT SAFETY ANALYSIS REPORT (SWESSAR-P1). Horn, F. H.; Hendricks, P. L. (eds.). (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Apr 1975. 34p. Dep. NTIS $4.00.

An index is presented for microfiche copies of material submitted through January 17, 1975, by Stone and Webster Engineering Corporation as a standard safety analysis report for pressurized water reactors. Citations refer to items and grid coordinates and are given for major headings or topics of primary interest. (auth)

5759 (NUREG/PRDI-75/5) POWER REACTOR DOCKET INFORMATION. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). May 1975. 41p. TIC $1.85.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U. S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DCC)

5760 (RDT-INDEX-3-75) INDEX OF RDT STANDARDS. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). Mar 1975. 91p. RSO.

5761 (RDT-STATUS-(3-75)) BIMONTHLY STATUS REPORT OF RDT STANDARDS. (Energy Research and Development Administration, Washington, D. C. (USA). Div. of Reactor Research and Development). 31 Mar 1975. 57p. RSO Free.

5762 (REG/G-1.85(Rev. 1)(4-75)) CODE CASE ACCEPTABILITY. ASME Section III materials. (Nuclear Regulatory Commission, Washington, D. C. (USA). Office of Standards Development). Apr 1975. 5p. NRC.

This regulatory guide lists those Section III ASME Code Cases oriented to materials and testing that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants. (auth)

5763 RECENT STATE INITIATIVES ON POWER PLANT SITING: A REPORT AND COMMENT. Best, J. A. (Cornell Energy Project, Ithaca, NY). Natur. Resour. Lawyer; 5: No. 4, 668-680(Fal 1972).

A discussion is presented of recently enacted legal provisions affecting power plant siting. Included are aspects of power plant siting regulations of Arizona, Connecticut, Maine, Maryland, New Hampshire, New Mexico, New York, Oregon, South Carolina, Vermont, and Washington. Emphasis is placed on the procedures and requirements adopted by the state of Maryland. (DG)

5764 QUALITY ASSURANCE IN THE CONSTRUCTION OF NUCLEAR POWER PLANTS. Bernsen, S. A. Nucl. Safety; 16: No. 2, 127-141(1975).

A general survey of quality-assurance (QA) practices as they relate to the construction phase of nuclear power plants is presented. The article briefly outlines the evolution of construction QA requirements, describes construction practices and organizational relations that help identify the unique construction-phase features that affect QA practices, identifies some of the principal requirements and programmatic problems involving construction,

and discusses potential trends and suggested guidelines for the implementation of particular practices. (auth)

5765 QUALITY CONTROL FOR PLATE-TYPE URANIUM-ALUMINUM FUEL ELEMENTS. Hinsdale, IL; American Nuclear Society (1974). 12p. (ICONS-01999).

This standard sets forth general requirements for the establishment and execution of a program designed to verify that the quality of plate-type uranium-aluminum fuel elements being purchased for research reactors conforms to the requirements of the contract and applicable technical documents, including specifications, standards, and drawings. The quality verification program prescribed herein comprises the elements of an inspection system, including planning, documentation, surveillance, inspection, testing, and certification. This document also includes elements of inspection control, test and measuring equipment, non-conforming items, and corrective actions. (auth)

5766 IEEE GUIDE FOR GENERAL PRINCIPLES OF RELIABILITY ANALYSIS OF NUCLEAR POWER GENERATING STATION PROTECTION SYSTEMS. New York; Institute of Electrical and Electronics Engineers, Inc. (1975). 74p. (ICONS--01998).

This document was prepared to provide the designers and operators of nuclear power plant protection systems and the concerned regulatory groups with the essential methods and procedures of reliability engineering that are applicable to protection systems. By applying principles given, systems may be analyzed, acceptable test intervals may be established, results may be reconciled with reliability objectives, and the analyses may be suitably documented. The quantitative principles are applicable to the analysis of the effects of random failures on protection system reliability. They are not intended for use in treating the problem of systematic or common-mode failure. (auth)

5767 DECISION ANALYSIS FOR THE SITING OF NUCLEAR POWER PLANTS: THE RELEVANCE OF MULTIATTRIBUTE UTILITY THEORY. Keeney, R. L. (Massachusetts Inst. of Tech., Cambridge); Nair, K. Proc. IEEE (Inst. Elec. Electron. Eng.); 63: No. 3, 494-501(Mar 1975).

The necessity for improved decision making concerning the siting and licensing of major power facilities has been accelerated in the past decade by the increased environmental consciousness of the public and by the energy crisis. These problems are exceedingly complex due to their multiple objective nature, the many interest groups, the long-range time horizons, and the inherent uncertainties of the potential impacts of any decision. Along with the relatively objective economic and engineering concerns, clearly the more subjective factors involving safety, environmental, and social issues are crucial to the problem. Hence, the professional judgments and knowledge of experts in these areas should be utilized in analyses of siting decisions. Likewise, the preferences of the general public, as consumers, the utility companies, as builders and operators of power plant facilities, and environmentalists and the government must be accounted for in analyzing power plant siting and licensing issues. We advocate an approach for formally articulating the experts' judgments and the decision makers' preferences, both of which are clearly subjective, and processing these along with the more objective considerations in a logical manner to acquire the implications for decision making. The appropriateness and application of decision analysis for power plant location decisions is discussed and illustrated. Emphasis is placed on the assessement of the decision makers' preferences and tradeoffs concerning multiple objectives. (auth)

5768 DEVELOPMENT, GROWTH, AND STATE OF THE NUCLEAR INDUSTRY. Hearings Before the Joint Committee on Atomic Energy, Congress of the United States, Ninety-Third Congress, Second Session on Developments in the Energy Industry in General and the Nuclear Power Industry in Particular, Pursuant to Section 202 of Atomic Energy Act of 1954, as Amended, February 5 and 6, 1974. Washington, DC; Joint Committee on Atomic Energy (1974). 611p. GPO $5.00.

5769 TECHNICAL INSPECTORATES ACTING AS EXPERT CONSULTANTS AND INSPECTORS IN THE LICENSING PROCEDURE UNDER THE ATOMIC ENERGY LAW. Vetter, H. (Technischer Ueberwachungs-Verein Baden e.V., Mannheim (F. R. Germany)). Tech. Ueberwach.; 15: No. 12, 431-435 (Dec 1974). (In German).

The German reactor building industry has caught up with the worldwide state of the art as far as the development status is concerned. Under the German Atomic Law the safety of nuclear power stations ranks first and foremost in the planning efforts. The Technische Ueberwachungsvereine (Technical Inspectorates) act as consultants in the planning phase and have established the Institut fuer Reaktorsicherheit (IRS) for studies of special problems. Their consultant activities include preliminary examination of the planning documents, investigations accompanying the fabrication phase, controls during the commissioning phase and subsequent in-service inspections. In the absence of any binding rules it is unavoidable that inspection duties vary from case to case. Delays in the timetable of the licensing procedure are to be avoided in the future by streamlining the licensing procedure and standardizing nuclear power station components. (GE)

GENERAL AND MISCELLANEOUS

Civilian Defense

5770 (JPRS-63455) CONSTRUCTION OF QUICKLY ERECTABLE BLAST AND RADIATION SHELTERS. Ostroukh, F. I. 18 Nov 1974. Translation of Stroitelstvo Bystrovozvodimykh Ubezhishch i Protivoradiatsionnykh Ukrytii, Moscow, 1972. 118p. NTIS $5.25.

The report contains data on the construction of protective structures and radiation shelters and recommendations for various types of materials to be employed. (GRA)

Energy Utilization and Economics

5771 SYNTHETIC FUELS DATA HANDBOOK. Hendrickson, T. A. (comp.). Denver; Cameron Engineers, Inc. (1975). 401p.

The handbook is made up of 3 main sections: Green River Oil Shales, U. S. Coal, and Alberta Oil Sands. This extensive collection of data places emphasis on properties of oil shale, tar sands, and coal and methods for production of synthetic fuels from these fossil fuels. The two-part appendix includes discussions on coal conversion processes investigated prior to 1965 and the Modified Fischer Assay. (378 references) (JGB)

Information Handling

5772 (AD/D-002617) ANNUAL REPORT OF THE METALS AND CERAMICS INFORMATION CENTER. Report No. 3, 1 August 1973–31 July 1974. Moran, H. D.; Lynch, J. F. (Battelle Columbus Labs., Ohio (USA)). Sep 1974. 43p. NTIS $3.75.

The metals and ceramics information center (MCIC) is one of several technical information analysis centers chartered and sponsored by the Department of Defense. During this period, advances were made in expanding the user community, as well as improvements in the management of the information base. The MCIC computerized files were increased by addition of 3205 references, 289 technical inquiries were received (146 processed), one new MCIC handbook and a major supplement to an existing handbook were issued. (GRA)

Law

Refer also to abstracts 3702 and 5650.

Management

Refer also to abstract 3455.

5773 (ERDA-10) INTERAGENCY RADIOLOGICAL ASSISTANCE PLAN. (Energy Research and Development Administration, Washington, D. C. (USA)). Apr 1975. 31p. Dep. NTIS $4.75.

The Interagency Radiological Assistance Plan (IRAP) was developed in 1961 and revised in April 1975 by an interagency committee of Federal agency representatives as a means for providing rapid and effective radiological assistance in the event of a peacetime radiological incident. The IRAP provides a means whereby the 13 participating Federal agencies may coordinate their radiological emergency related activities with those of state and local health, police, fire and civil defense agencies. The Plan also provides operating guidelines for interagency radiological emergency operations and training. (CH)

5774 (INIS-mf-1655) AEB-HIGHLIGHTS. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jan 1974. 7p. INIS.

AEB Highlights is a half-yearly report reflecting the most important recent achievements of the various Research and Technical Divisions of the Atomic Energy Board. It appears alternately in English and Afrikaans. (INIS)

5775 (INIS-mf-1678) ATOMIC ENERGY BOARD SEVENTEENTH ANNUAL REPORT, 1973. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). 1973. 60p. INIS.

Progress is reported on the following: nuclear materials, nuclear power, application of radioisotopes and radiation, health and safety and fundamental studies undertaken in physics, chemistry, metallurgy, medicine and geology during 1973. The technical activities on the site are summarized as well as the external negotiations undertaken. The staff organization and finance is given. The report also contains a list of publications published during 1973 by staff members and bursars of the Board. (INIS)

5776 (ORNL-TM-4837) GENERAL WRITING-INFORMATION PACKET FOR THE ENVIRONMENTAL IMPACT PROJECT. Raaen, H. P. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 56p. Dep. NTIS $6.00.

The information packet was prepared primarily for internal use at Holifield National Laboratory. The contents include suggestions to authors of environmental statements; format of environmental statements; formats of references given in environmental statements; preparation of SELECTED BIBLIOGRAPHY; troublesome words; glossary; abbreviations, initialisms, and symbols; and MT/ST taping procedure. (MCW)

5777 (RISO-300) PHYSICS DEPARTMENT ANNUAL PROGRESS REPORT, 1 JANUARY–31 DECEMBER 1973. Bjerrum Moeller, H.; Lebech, B. (eds.). (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec 1973. 80p. INIS.

The research work in the Physics Department at Risø covers four main fields: solid-state physics, plasma physics, nuclear spectroscopy and meteorology. The solid-state physics section utilizes thermal neutron beams from the DR3 reactor for experimental studies of solids and liquids. The investigations are roughly classified as lying within the following fields: magnetism, lattice dynamics, liquids, and amorphous materials. The nuclear physics section works on problems related to fission. The plasma physics section works primarily in two fields: technology of interest for future fusion reactors (utilizing a puffatron and a magnetically driven shock tube) and basic plasma properties (utilizing a Q-machine). The meteorology section is primarily engaged in studies of the planetary boundary layer. (INIS)

5778 PRESENTATION OF RESULTS OF NUCLEAR DATA MEASUREMENTS. Schmidt, J. J. (International Atomic Energy Agency, Vienna); Bartholomew, G. A. Int. J. Appl. Radiat. Isotop.; 26: No. 1, 45(Jan 1975).

A set of recommendations to authors and editors of nuclear physics journals originally issued in 1972 by the International Working Group on Nuclear Structure and Reaction Data and recently endorsed by the IAEA Meeting in Nuclear Data for Applications is presented. (UK)

5779 ADVANCED NUCLEAR RESEARCH. Hearing Before the Subcommittee on Aeronautics and Space Technology of the Committee on Science and Astronautics, U. S. House of Representatives, Ninety-Third Congress, Second Session, February 7, 1974. Washington, DC; Committee on Science and Astronautics (1974). 78p. GPO.

Major objectives of the session were to obtain a better understanding of how the results of nearly $1.5 billion worth of nuclear power and propulsion research and development will be kept available for use in the future, to determine how NASA and the AEC will maintain a viable long-range capability in advanced nuclear power and propulsion research, and to determine how the results of both past and future research can be incorporated in applications for solving problems related to energy and other terrestrial applications. Witnesses were David S. Gabriel, Director, Space Nuclear Systems Division, U. S. Atomic Energy Commission; Francis C. Schwenk, Director, Research Division, Office of Aeronautics and Space Technology, National Aeronautics and Space Administration; Max Johnson, general manager, Westinghouse Astronuclear Laboratory; Dr. Edgar A. Womack, Assistant Director, Gas Cooled Reactor Project, U. S. Atomic Energy Commission; Dr. R. E. Schreiber, Deputy Director, Los Alamos Scientific Laboratory; Dr. George N. Hatsopoulos, president, Thermo Electron Corp.; and Thomas S. Latham, senior research engineer, United Aircraft Research Laboratories. Subjects considered included the following: thermionic energy conversion research, Brayton energy conversion systems, plasma core reactor research, thermonuclear fusion research, central station nuclear power, nuclear process heat, advanced concepts, the Rover program, ultra-high temperature reactors, process heat reactors, packaged nuclear power plants, light-weight marine propulsion power plants based on high-temperature gas-cooled reactors, and gaseous nuclear rocket technology. (RWR)

5780 POWER PROGRAMME. Mattocks, R. G.; Mathias, D. J. J. Inst. Nucl. Eng.; 15: No. 6, 176-181(Nov 1974).

The history of the UK nuclear power programme is first summarized, followed by consideration of the following: the steam generating heavy water reactor; the CEGB installed capacity, fuel consumed, and cost); and future systems (high temperature gas cooled reactors; fast breeder reactors; fusion reactors). Among conclusions reached is that it must be recognized that

ultimately there is no alternative to nuclear generation unless there is a major breakthrough in solar or tidal generation coupled with massive energy storage systems. (UK)

Mathematics and Computers

Refer also to abstract 5460.

Miscellaneous

5781 (BNL-19847) AEROSOL PRODUCTION FROM LAND APPLICATION OF WASTEWATER BY AGRICULTURAL IRRIGATION EQUIPMENT. Raynor, G. S.; Hayes, J. V. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 4p. (CONF-750432-2). Dep. NTIS $4.00.

From Ag-meteorological conference; Tucson, Arizona, USA (14 Apr 1975).

Aerosol production from sprays of four agricultural nozzle systems was studied by sampling dye particles resulting from evaporated spray droplets. The percent of water aerosolized was small but 10^{10} or more particles were produced per minute from single nozzles. Most aerosol-forming droplets were under 100 μm. (auth)

5782 (COO-2482-2) DIRECT IMAGE RECONSTRUCTION OF GEOLOGICAL STRUCTURES VIA REMOTE SENSING. Bleistein, N. (Denver Research Inst., Colo. (USA); 1974. Contract AT(11-1)-2482. 24p. Dep. NTIS $4.25.

It is shown how to process backscattered acoustic data to directly generate the image of a geological structure. The result is based on a physical optics far field inverse scattering (POFFIS) identity. This identity states that a phase and range normalized scattering amplitude is proportional to a function which is unity in the region of the geological structure and zero outside that region. (auth)

5783 (COO-2482-3) REMOTE SENSING OF GEOLOGICAL STRUCTURE VIA ANALYSIS OF THE INVERSE PROBLEM IN ACOUSTICS AND ELECTROMAGNETICS. Progress Report. Bleistein, N. (Denver Univ., Colo. (USA)). 15 Mar 1975. Contract AT(11-1)-2482. 8p. Dep. NTIS $4.00.

The development of physical optics far field inverse scattering (POFFIS) identity for the remote sensing of geological structure is described. The POFFIS identity provides a means for direct image reconstruction from backscattered data. It is applicable to anticlines, synclines or faults in an otherwise planar layer in those cases in which the lower region may be reasonably approximated as being acoustically hard or acoustically soft. A detailed description dealing with the propagation of internal gravity waves is given. The problem is described in terms of a system of partial differential equations for the motion of the fluid. This system is converted into dimensionless form via an appropriate scaling analysis, and linearized by allowing small perturbations from the ambient state. The solution technique is based on an application of a multi-dimensional Fourier transform in the time and transverse spacial variable. (MCW)

5784 (COO-2484-3) STUDY OF SEISMICITY AND TECTONICS IN NEW ENGLAND. Second Quarterly Report, November 1, 1974–January 31, 1975. (Boston Coll., Weston, Mass. (USA). Weston Observatory). 1975. Contract AT(11-1)-2484. 11p. Dep. NTIS $4.00.

Contractural activities are summarized for progress on telemetry circuits and equipment and instrumentation. Quarry blast and earthquake data are summarized for the New England area. (MCW)

5785 (EPA-670/2-74-096) CHARACTERIZATION AND TREATMENT OF URBAN LAND RUNOFF. Colston, N. V. Jr. (North Carolina State Univ., Raleigh (USA). Dept. of Civil Engineering). Dec 1974. 170p. TIC.

Urban land runoff from a 1.67 square-mile urban watershed in Durham, North Carolina, was characterized with respect to annual pollutant yield. Regression equations were developed to relate pollutant strength to hydrograph characteristics. Urban land runoff was found to be a significant source of pollution when compared to the raw municipal waste generated within the study area. (auth)

5786 (PB-237383) REPORT OF NRL PROGRESS. (Naval Research Lab., Washington, D. C. (USA)). Jun 1974. 75p. NTIS $4.25.

The contents include: metallurgy at NRL-research advances and projections for the future; the thermomechanical response of materials to pulsed radiation heating; electrochemical aspects of stress-corrosion cracking–recent SCC studies of high-strength steels; progress notes in acoustics, chemistry, mathematics, metallurgy, nuclear sciences, oceanography, ocean technology, optical physics, radar, and space science. (GRA)

5787 (UCRL-14247) ONE-LAYER, HOMOGENOUS, WIND-DRIVEN NORTH PACIFIC OCEAN. Crowley, W. P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Jun 1965. 25p. Dep. NTIS $4.25.

A numerical model of wind-driven currents in a one-layer, homogenous North Pacific Ocean is presented based on the time dependent, nonlinear primative equations. Sound waves are eliminated, but a free upper surface allows the existence of gravity waves. Numerical stability and boundary conditions are discussed. Results are presented which qualitatively agree with measured ocean currents. (auth)

Chemistry

5788 (ARH-SA-202) GEOCHEMICAL CLASSIFICATION OF DIKES OF THE GRANDE RONDE SWARM, COLUMBIA RIVER BASALT. Price, S. M. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). May 1974. Contract AT(45-1)-2130. 33p. Dep. NTIS $4.75.

Analysis of approximately 40 major Columbia River Basalt dikes of the Grande Ronde swarm, northeastern Oregon-southeastern Washington, revealed that these dikes can be divided into six chemical classes. The compositions of dikes of four of these classes are comparable with the Yakima, Umatilla, Lolo, and Frenchmen Springs chemical types of Wright and others (1973). The dikes of the remaining two classes have an average content of 47.4% SiO_2, 10.3% CaO, 1.7% TiO_2, 0.49% K_2O, and 7.9% MgO; and 51.5% SiO_2, 9.5% CaO, 1.4% TiO_2, 0.75% K_2O, and 5.8% MgO. Analysis of Columbia River Basalt flows of the swarm area disclosed that lower Yakima flows (as defined by Wright and others, 1973) are chemically comparable to dikes of Yakima-type chemistry and that middle Yakima flows are chemically comparable to dikes of one of the remaining five classes. The dike-flow relations indicated by chemistry can be substantiated by field evidence. The study revealed that several flows and related dikes of the Grande Ronde area are chemically equivalent to Pasco Basin flows characterized by the Atlantic Richfield Hanford Company. (auth)

5789 (CEA-CONF-2723) DETERMINATION OF IMPURITIES IN MERCURY. Franc. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). Jan 1974. 4p. (In French). (CONF-731162-1). Dep. NTIS (US Sales Only) $4.00.

From meeting of the group for the advancement of spectrographic methods; Paris, France (22 Nov 1973).

The techniques used and the precautions taken in the determination of impurities in Hg by emission spectroscopy and atomic absorption are described. In the emission spectroscopy method, the trace elements Ag, Al, Au, Bi, Cd, Co, Cr, Cu, Fe, Mg, Mn, Ni, Pb, Sn, and Zn can be determined after nitric acid dissolution of the sample followed by oxidation of the Hg. In the atomic absorption method the trace elements Ca, Cr, Cu, Fe, Li, Mg, Mn, Ni, and V can be determined. The special technique derived from atomic absorption to determine Ag and Mo is described. (JSR)

5790 (CEA-CONF-2782) OPTICAL OXYGEN ANALYZER FOR HYPERBARIC (60 BARS) BREATHABLE MIXTURE. Bertrand, G.; Jourdan, P.; Rebiere, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. d'Applications Speciales de la Physique). Apr 1974. 13p. (In French). (CONF-741089-1). Dep. NTIS (US Sales Only) $4.00.

From 2nd international symposium of the exploration of oceans; Bordeaux, France (1 Oct 1974).

The optical oxygen analyzer is a self governing, portable and small size apparatus, designed for partial pressure oxygen measurements in hyperbaric breathable mixtures used in sea-diving or in diving-chamber. Oxygen strongly absorbs ultraviolet light in the Schumann region (near 1,450 Å, about 50% of intensity is absorbed along a path of 0.1 mm long in air). An ultraviolet beam emitted from a low pressure xenon discharge lamp is split in two fractions. One of them crosses through a measurement gap and the other is a reference signal. Detector may be, either a differential ionization gas chamber or a double photocathode. In these two cases, the ratio of signals is proportional to the partial pressure of oxygen: $\ln (I_0/I) = k\,p \times 273/T$, (k = coefficient of attenuation, p = partial pressure, x = gap width, T = absolute temperature). It was found that usual concentration of water vapor and carbon dioxide was weak and that the accuracy of measurement was ±10 mb at 300 mb. Transparency of helium up to 60 bars was verified. A prototype tested in laboratory and in an experimental diving-chamber is described. The main characteristics of this apparatus are good accuracy and short response time. (tr-auth)

Life Sciences

5791 (BNL-19848) DISPERSION OF PARTICULATES FROM INFOREST RELEASES. Raynor, G. S.; Hayes, J. V.; Ogden, E. C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1975. 4p. (CONF-750432-3). Dep. NTIS $4.00.

From Ag-meteorological conference; Tucson, Arizona, USA (14 Apr 1975).

Selected pollens and spores were released from continuous point sources in and above a pine forest and sampled by a three-dimensional grid of rotoslide samplers. Data were analyzed to determine plume behavior, rate and mechanism of particle loss, and effects of particle size and meteorological parameters. Results showed many similarities to, but some differences from, results over grassy fields. (auth)

5792 (BNWL-SA-5192) TURBULENCE TIME AND LENGTH SCALES IN AN URBAN ENVIRONMENT. Ramsdell, J. V. Jr.; Clark, G. H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1974. Contract AT(45-1)-1830. 10p. (CONF-741110-2). Dep. NTIS $4.00.

From 6th conference on aerospace and aeronautical meteorology; El Paso, Texas, USA (12 Nov 1974).

As a portion of a study to provide meteorological information for use in development of vertical and short take-off and landing aircraft for operation to and from an urban environment, extensive turbulence measurements were made at three locations in Seattle, Washington. In this paper, data obtained from these measurements are examined to determine the characteristics of turbulence time and length scales in an urban environment. The behavior of the average time and length scales is found to depend only upon the wind speed and height above ground for the horizontal wind components and height above ground for the vertical component. Models are developed for the length scales. Time and length scales for each component of the wind are distributed in a log-normal manner with constant standard deviations. These standard deviations are given for each site and component. (auth)

5793 (CALT-767P6X10) STUDIES IN DEVELOPMENTAL IMMUNOGENETICS. Annual Progress Report. Owen, R. D. (California Inst. of Tech., Pasadena (USA). Div. of Biology). 26 Mar 1975. Contract AT(04-3)-767. 17p. Dep. NTIS $4.00.

Progress is reported on studies on the genetic regulation in complex organisms, with emphasis on the immune system as a model for developmental analysis and as a tool for following the development of other systems, especially the brain. It includes results of studies of biochemical genetics, primarily from a developmental viewpoint and with particular regard to defense mechanisms, and cellular aspects of the immune system. It extends into the area of cancer immunology and cell specificities as related to tumor systems, primarily from an immunogenetic viewpoint and with particular reference to leukemias in the mouse, and to disruptions of genetic control mechanisms in tumor development, especially as approached through the reappearance of fetal antigens associated with tumor development. (auth)

5794 (CEA-CONF-2761) CONTROVERSIAL ASPECTS OF IONIC UPTAKE IN FRESHWATER ANIMALS. Maetz, J.; Payan, P.; de Renzis, G. (CEA Station Zoologique de Villefranche, 06 (France). Groupe de Biologie Marine). 1975. 28p. (CONF-740746-1). Dep. NTIS (US Sales Only) $4.50.

From 50th anniversary meeting of the Society of Experimental Biology; Cambridge, UK (20 Jul 1974).

5795 (CONF-740103-1) MEASUREMENTS OF OPTICAL AND NOISE PROPERTIES OF SCREEN-FILM SYSTEMS IN RADIOGRAPHY. Doi, K.; Rossmann, K. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA); Chicago Univ., Ill. (USA). Dept. of Radiology). 1974. 27p. Dep. NTIS $4.50.

From conference on structure-property relationships in thick film and bulk coatings; San Francisco, California, USA (28 Jan 1974).

Methods of measuring the MTF (modulation transfer function) and the Wiener spectrum of screen-film systems are described, and experimental results of three screen-film systems are presented. Extensive knowledge concerning measurement of the MTF by the slit method is now available. Further refinements of the measurement of the Wiener spectrum may be accomplished in the future. (auth)

5796 (CONF-750425-3) GROWTH RATES OF SUBADULT LARGEMOUTH BASS, 24-35.5°C. Coutant, C. C.; Cox, D. K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 10p. Dep. NTIS $4.00.

From 2nd thermal ecology symposium; Augusta, Georgia, USA (2 Apr 1975).

Subadult largemouth bass, Micropterus salmoides, weighing 26 to 243g were held at 13 temperatures from 24.0 to 35.5°C and were weighed weekly to determine growth rates. They were fed live, adult fathead minnows, Pimephales promelas, ad libidum. The bass grew fastest at 26 to 28°C, with zero growth estimated to be near 35.5°C. The temperature of zero growth was about 1.0°C less than the ultimate incipient lethal temperature reported in the literature. (auth)

5797 (COO-1198-1099) PIEZOELECTRIC RESPONSE OF BONE AND TENDON SUBJECTED TO INHOMOGENEOUS STRESS (CHAPTERS I–IV). Breger, L. H. (Illinois Univ., Urbana (USA). Dept. of Physics). Oct 1974. Contract AT(11-1)-1198. 335p. Dep. NTIS $19.75.

Thesis.

5798 (COO-1198-1142) INVESTIGATION OF PREFERENTIAL ETCH PATTERNS CREATED IN HUMAN DENTAL ENAMEL DURING ACID ATTACK. Petty, D. S. (Illinois Univ., Urbana (USA)). Oct 1974. Contract AT(11-1)-1198. 62p. Dep. NTIS $6.25.

Thesis.

The phenomenon of preferential etching in human dental enamel is discussed in light of contemporary knowledge of the structure of the enamel prisms and the results of five experiments. Evidence is presented to discard the theory of crystallite orientation as the cause of acid etch patterns. The existence of a boundary diffusion barrier is proposed to account for the etching effects created by acids at low pH and their similarity to etching effects created by ion bombardment. A small but measurable difference in the Ca/P ratio between the center and boundary region of an enamel prism was found. (auth)

5799 (COO-1599-80(Pt.3)) ROLE OF CALCIUM CARBONATE PRECIPITATION IN LAKE METABOLISM. White, W. S. (Michigan State Univ., East Lansing (USA). Dept. of Botany and Plant Pathology). 1974. 157p. Dep. NTIS $11.00.

Thesis.

During a two year period analyses were made every other week on seston collected at three depths in a small hard-water lake in southwestern Michigan. The seston was analyzed for total dry weight, organic material, calcium carbonate, and ash content. During the second year seasonal changes in sestonic particulate, organic carbon, Kjeldahl nitrogen, and total phosphorus were assayed. Organic material and ash content of the seston were similar both years, but the calcium carbonate content was five times greater in the second year than in the first. The dissimilarity in calcium carbonate precipitation between the two years was related to degree of vernal circulation and calcium ion concentration in the water column when the ice broke up. During the study an improved sediment trap was designed and constructed. The trap had replicated, discrete upper and lower sections, which permitted correction for attached and non-sedimenting matter. (auth)

5800 (COO-1599-92(Pt.1)) DISSOLVED ORGANIC MATTER AND LAKE METABOLISM. Technical Progress Report, 1 July 1974–30 June 1975. Wetzel, R. G. (Michigan State Univ., East Lansing (USA)). 1975. Contract AT(11-1)-1599. 35p. Dep. NTIS $4.75.

Progress is reported on studies of the qualitative and quantitative cycling of particulate and dissolved organic matter in lake systems, with emphasis on the relationship between rates of carbon cycling and regulatory mechanisms of growth of phytoplankton, sessile algae, and bacterial populations. (CH)

5801 (COO-2084-18) STUDIES WITH INFECTIOUS FRAGMENTS OF PHAGE DNA. Progress Report, April 1, 1974–March 30, 1975. Schachtele, C. F. (Minnesota Univ., Minneapolis (USA)). 1975. Contract AT(11-1)-2084. 37p. Dep. NTIS $5.00.

Studies were continued on the small, virulent Bacillus subtilis bacteriophage phi 29. Recent studies identified a new cistron, cistron 0, and its product the lower collar protein. Two cistrons coding for structural proteins or their regulation have been positioned on the genetic map and mutants in cistron J were mapped. The product of this cistron is cleaved to generate the neck appendage of the virion. Integration of our genetic map with that of Moreno et al. has begun. A replicating membrane-bound form of phi 29 DNA and two free cytoplasmic forms have been detected by Renografin gradient analysis. Association with a phi 29-specific protein appears to be responsible for the differentiation between the latter two forms of DNA. A pathway for the maturation of the head of phi 29 has been proposed and integrated with our understanding of phi 29 DNA synthesis. Attachment of the neck appendages has been shown to be the last step in virus maturation and can occur only if the appendage protein is cleaved from a higher molecular weight precursor. (auth)

5802 (COO-2101-24) SYNTHESIS OF DNA CONTAINING URACIL OR HYDROXYMETHYLURACIL DURING BACTERIO-

PHAGE INFECTION OF BACILLUS SUBTILIS. Technical Progress Report, August 1, 1974–July 31, 1975. Price, A. R. (Michigan Univ., Ann Arbor (USA). Dept. of Biological Chemistry). 1975. Contract AT(11-1)-2101. 9p. Dep. NTIS $4.00.

Results are reported for studies on the synthesis of proteins and nucleic acids in relation to the effects of phage PBS2 on uracil-containing DNA in Bacillus subtilis, which normally makes thymine-containing DNA. (CH)

5803 (COO-2498-1) REPRODUCTIVE TEMPERATURE TOLERANCE OF A DESERT PUPFISH. Technical Progress Report, July 1, 1974–June 30, 1975. Gerking, S. D. (Arizona State Univ., Tempe (USA). Dept. of Zoology). 1975. Contract AT(11-1)-2498. 6p. Dep. NTIS $4.00.

Male and female fish were placed in aquaria at 28°C and observations were made on reproductive behavior, number and sequence of days on which eggs were laid, number of eggs laid, and length and weight of fish. When fish were exposed to temperatures of 20 and 22°C the reproductive behavior was inhibited. (HLW)

5804 (COO-3369-1) INSTITUTE OF LABORATORY ANIMAL RESOURCES, ASSEMBLY OF LIFE SCIENCES, DIVISION OF BIOLOGICAL SCIENCES. Annual Progress Report, 1 January 1974–31 December 1974. (National Academy of Sciences - National Research Council, Washington, D. C. (USA)). 1974. Contract AT(11-1)-3369. 19p. Dep. NTIS $4.00.

5805 (COO-3419-11) STUDIES ON VIRUS-INDUCED CELL FUSION. Progress Report, August 1, 1974–July 31, 1975. Person, S. (Pennsylvania State Univ., University Park (USA)). 1975. Contract AT(11-1)-3419. 17p. Dep. NTIS $4.00.

Results are reported from studies on the mechanism of cell fusion induced in cultural animal cells by fusion-causing mutants of Herpes simplex virus. (CH)

5806 (LA-5899-PR) DEVELOPMENT OF A CELL-ANALYSIS AND SORTING SYSTEM APPLICABLE TO TUMOR CELL CHARACTERIZATION AND KINETIC STUDIES. Progress Report, September 1, 1974–March 1, 1975. Mullaney, P. F.; Salzman, G. C.; Crissman, H. A. (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1975. Contract W-7405-ENG-36. 2p. Dep. NTIS $4.00.

The major emphasis was on completion of the multiparameter cell-sorting and analysis instrument designed by the Los Alamos Scientific Laboratory (LASL) for the National Cancer Institute (NCI). This is a computer-based system with LASL responsibility for software development during the second program year (June 1, 1975, to June 1, 1976). At this writing, the computer section of the sorter has been delivered, and the hardware portion of the system is being prepared for shipment. The biological portion of this program has stressed the dispersal, fixation, and staining of material of particular interest to the NCI. Experiments have been conducted with both in vivo and in vitro systems supplied by the NCI. Details of the analysis of this material are contained in this progress report. (auth)

5807 (LA-UR-75-621) CELLULAR DNA CONTENT AND CHROMOSOME NUMBER IN HETEROPLOID CELL POPULATIONS. Deaven, L. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 7 Apr 1975. Contract W-7405-ENG-36. 16p. Dep. NTIS $4.00.

Following treatment of Chinese hamster cells with low doses of Colcemid to induce chromosome nondisjunction, DNA dispersion was shown by flow microfluorometry. Cloval selection of HeLa populations provided subcultures with small perimodal chromosome distributions of 2 chromosomes. Data show that the variability in heteroploid cells cannot be explained by mitotic nondisjunction. Studies were initiated to establish the DNA content and chromosomal composition of several item lines within a heteroploid population of Chinese hamster cells. Populations derived from selected clones were examined to determine the stability of chromosome number, DNA content, and chromosome structure. (HLW)

5808 (ORNL-EMIC-4) CHEMICAL MUTAGENESIS. A Survey of the 1973 Literature. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. 385p. Dep. NTIS $22.25.

The fifth computer-generated annual survey of chemical mutagenesis prepared by the Environmental Mutagen Information Center contains 2,727 references, 1,962 published in 1973 and 765 published in the years 1969 through 1972 but not included in previous annual surveys. The publication contains seven indexes: citation, agent, author, KWIC, Chemical Abstracts Service Registry Number, taxonomic, test object, and the general article section which contains reviews and other articles unsuitable for detailed indexing. (HLW)

5809 (ORO-3630-21) PHOTOREPAIR OF UV DAMAGE TO DNA: PURIFICATION AND PROPERTIES OF DNA PHOTOLYASE (THE DNA-PHOTOREACTIVATING ENZYME). Progress Report, August 1, 1974–July 31, 1975. Werbin, H. (Texas Univ., Dallas (USA). Inst. for Molecular Biology). 1975. Contract AT(40-1)-3630. 19p. Dep. NTIS $4.00.

Results are reported from studies on the preparation and properties of DNA photolyase. (CH)

5810 (ORO-4465-7) PRODUCTION, PURIFICATION, AND ASSAY OF THROMBOPOIETIN. Progress Report, June 1, 1974–July 31, 1975. McDonald, T. P. (Tennessee Univ., Knoxville (USA). Memorial Research Center and Hospital). 1975. Contract AT(40-1)-4465. 25p. Dep. NTIS $4.25.

Results are reported from studies on the use of human urine and sera as sources of thrombopoietin, the purification of thrombopoietin, the use of embryonic kidney cells in culture to produce thrombopoietin, and the detection of neutralizing antibodies in immune sera for thrombopoietin. (auth)

5811 (SRO-852-1) PLANKTON COMMUNITY STRUCTURE: EVALUATION OF ANALYTICAL METHODS USING MODEL COMMUNITIES. Annual Progress Report, June 15, 1974–March 15, 1975. Hayes, W. B. (Georgia Univ., Athens (USA). Dept. of Zoology). 12 Mar 1975. Contract AT(38-1)-852. 4p. Dep. NTIS $4.00.

5812 (UCB-34P156X7) DETECTION AND ANALYSIS OF MUTAGENS. Progress Report, July 1, 1974–June 30, 1975. Ames, B. N. (California Univ., Berkeley (USA). Dept. of Biochemistry). Mar 1975. Contract AT(04-3)-34. 10p. Dep. NTIS $4.00.

A biological system for the detection of environmental mutagens and carcinogens is described that consists of a set of three histidine-requiring mutants of Salmonella typhimurium coupled with a mammalian liver homogenate. Results of preliminary tests of the system are included. (CH)

5813 (UCLA-34P61-14) METABOLIC CONTROL OF TRANSPORT IN PLANT TISSUES. Progress Report. Laties, G. G. (California Univ., Los Angeles (USA)). [nd]. Contract (04-3)-34. 6p. Dep. NTIS $4.00.

Results are reported from studies on the metabolic control of respiration in thin-cut potato slices during storage. (CH)

5814 (UR-3490-712) THERMOREGULATORY CONSIDERATIONS IN THE NEUROLOGICAL RESPONSE TO MICROWAVE EXPOSURE. Michaelson, S. M. (Rochester Univ., N. Y. (USA). Dept. of Radiation Biology and Biophysics). 1974. 24p. Dep. NTIS $4.25.

The following topics are reviewed: thermoregulatory responses as direct effects of heat on the tissues or indirect reflex effects involving the central nervous system; neural effects of exposure to microwaves; functional alterations in the neuroendocrine system; effects of microwaves on the brain; and animal experiments on biological effects of microwaves. (HLW)

Materials

5815 (MHSMP-72-73) DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES. Progress Report, July–September 1972. Honea, F. I.; Wichmann, J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1972. 27p. Dep. NTIS $4.50.

An investigation of disposal and reclamation methods for waste and excess explosives with respect to air pollution guidelines is continued. Experimental data established the feasibility of large scale recovery using solvent extractions. Biodegradation test results indicated that bacteria and algae are adaptable to using explosives as a food. More tests are planned with a laboratory-scale recycle system. The samples to be evaluated in these tests will include a mixture of explosives in proportion to usual waste explosives amounts and will include the plastic binders. Sampling of average NO_2 concentrations in the air was continued, and the preliminary data in this investigation indicate that the NO_2 concentration around the open burning site is comparable to the ambient level in other areas. Installation of a pilot high explosive incineration facility using a rotary calciner is scheduled for completion in May 1973. Modifications and further tests of a closed-pit incinerator were made. (PMA)

5816 (MHSMP-73-11) DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES. Progress Report, January–March 1973. Honea, F. I.; Barnard, J. L.; Bullerdiek, W. A.; Mehrhoff, T. K. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1973. 32p. Dep. NTIS $4.75.

An investigation of disposal and reclamation methods for waste and excess explosives with respect to air pollution guidelines is continued. Results are reported for extended term biodegradation studies, and a bench scale biodegradation system is being planned to evaluate the degradation of typical waste HE (high explosives) material with binders included. In order to gain

more knowledge of the types and amounts of pollutants which may evolve from open burning of high explosives, laboratory scale simulation of such burning was conducted, and pollution levels for five different explosives and automobiles are compared on an output per day basis. Contracts were awarded in March 1973 for installation of the indirect fired, rotary pilot incinerator, and installation of the basic unit and control system is scheduled to be complete by July 1973. Additional tests of the prototype closed-pit incinerator are scheduled (weather has delayed testing). A conceptual design for the HE disposal facility was prepared and submitted to the AEC, and the details are presented. The facility utilizes incineration as the disposal method for HE and HE-contaminated materials, and the incinerators are based on the closed-pit incinerator concept being currently evaluated. (PMA)

Physics and Engineering

5817 (BNL-12681) EFFECT OF HIGH VELOCITY PROJECTILES ON CONCRETE–POLYMER. Steinberg, M.; Colombo, P.; Fontana, J.; Kukacka, L.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y. (USA)). Jul 1968. 7p. Dep. NTIS $4.00.

Two tests on the effect of ammunition on concrete-polymer material clearly indicate, in a qualitative manner, the marked improvement of the impact and antifragmentation properties of concrete-polymer compared to concrete alone. This suggests some interesting possible applications as low cost armor plate. These preliminary qualitative tests thus reveal that it would be well worthwhile pursuing a program which would further investigate and evaluate the preparation and properties of concrete-polymer for impact and antifragmentation resistance. (auth)

5818 (BNWL-SA-5268) AUTOMATION OF A BRAZING PROCESS WITH AN INTEL 8008 MICROPROCESSOR. Seim, T. A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1974. Contract AT(45-1)-1830. 15p. (CONF-750304-2). Dep. NTIS $4.00.

From conference on industrial applications of microprocessors; Philadelphia, Pennsylvania, USA (11 Mar 1975).

Automation of a brazing process involves measuring the temperature at the brazing point. The principal of operation necessary to control the process is explained. The selection of a microprocessor instead of a hard-wired system was for its programmability. The Intel 8008 design is very satisfactory for an industrial environment. It exhibited excellent noise immunity and is capable of 40 three-mode control computations per second. The process is being controlled at 10 per second. The economics of the microprocessor is a valuable criterion. (MCW)

5819 (CEA-CONF-2811) ON BOARD ELECTROLYTIC GENERATOR FOR BREATHABLE OXYGEN AND HYDROGEN UNDER 50 BARS. Perroud, P.; Sylvestre-Baron, M.; Terrier, G. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. d'Applications Speciales de la Physique). Sep 1974. 9p. (In French). (CONF-741089-2). Dep. NTIS (US Sales Only) $4.00.

From 2nd international symposium of the exploration of oceans; Bordeaux, France (1 Oct 1974).

Within the frame of the design of a pressurized (50 bars) electrolytic generator for breathable oxygen production on board of a nuclear submarine, many different problems have been overcome: porous metallic diaphragms, coatings for electrodes, intensity current distribution, circulation pump, and level probe sensor. A fully automatic apparatus built with two electrolytic cells, capable of 15 Nm^3/day of oxygen (under 50 bars) has performed continuously as long as 1,000 hours. The current density may be as large as 30,000 A/m^2 and the gas purity is better than 99.8%. Special care was devoted to minimize the size (1.2 × 0.8 × 2.25 m), to improve the fiability in sea conditions, and to ensure purity of oxygen attained. (tr-auth)

5820 (CONF-740726-2) PHOTOEMISSION STUDIES OF NaF AND KF IN THE 12 TO 23 eV REGION. Pong, W.; Smith, J. A. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). 1974. 8p. Dep. NTIS $4.00.

From 4th international conference on vacuum ultraviolet radiation physics; Hamburg, F.R. Germany (22 Jul 1974).

In order to develop a better understanding of the valence and conduction band states, measurements were performed in which uv photoelectron spectra of NaF and KF were obtained for photon energies up to 23 eV. The results show conduction band structure and the width of the F^-2p valence band. The photoelectron energy distribution curves are shown. (JFP)

5821 (COO-3247-29) GENERALIZED OSCILLATOR STRENGTHS. Progress Report, July 1, 1974–July 1, 1975. Lassettre, E. N. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 1975. Contract AT(11-1)-3247. 36p. Dep. NTIS $5.00.

Generalized oscillator strengths are given for the X tilde $^1A_1$ yields A tilde $^1B_1$ transition in H_2O at electron kinetic energies of incidence of 300, 400, 500 and 600 eV. The data used to calculate the excitation energy of the $^3B_1$ state (lowest) of H_2O. The result is 7.0 +- .1 eV where the uncertainty is an estimate not an upper bound. This confirms a previous conclusion that the 4.5 eV excitation, observed by several investigators, cannot be due to vertical excitation to the lowest $^3B_1$ state. The 4.5 eV excitation is not yet identified. Generalized oscillator strength determinations on CO_2 are also reported together with preliminary results on a survey of N_2 spectra, at several kinetic energies and angles, in the vicinity of 11.87 eV, the excitation energy for the transition X ^{1}SIGMA$^+$/sub g/ yields E ^{3}SIGMA$^+$/sub g/. Cross section determinations on 1^1S yields 2^3S transition in helium at high kinetic energy (supported by AFOSR) are also briefly described since the results are of considerable interest in the present research. (auth)

5822 (EUR-5232e) REPAIR PROCESSES: FUNDAMENTALS AND COMPUTATION. Garribba, S.; Reina, G.; Volta, G. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 72p. Dep. NTIS (US Sales Only) $6.75. EUR B. Fr. 100,-.

In reliability engineering and practice an important role is played by those units or components whose life characteristics change with time. The case is considered where change underlies a non-homogeneous Markov model. Simple repair processes then deal with a two-state alternating policy resulting from the superposition of acts of failure and of restoration both showing a continuous aging with time. Unit's availability can be expressed through linear differential equations or by means of integral equations. The two approaches reveal their equivalence. Asymptotic behavior, repair density and life distributions may be easily obtained. The problems of defining p.d.f. of forward recurrence time, of number of repairs and total safe time are also afforded. In other words, results are sought which may be used for the solution of a series of problems commonly encountered in the practice of repairable systems. These results find a thorough correspondence with developments already offered by the literature for renewal processes. Simple renewal processes would consist of the recurrent superposition of acts of failure and restoration both starting as new after each transition. The code AVACOM-ETARP (Availability Computation-Element Transient and Asymptotic Repair Process) allows computation of availability, of repair density and of failure density accounting any continuous time dependence of failure and restoration rate. Numerical results are shown with regard to a few practical situations. (auth)

5823 (IC-74-14) REMARKS ON THE RENORMALIZATION GROUP APPROACH TO ANTIFERROMAGNETIC CRITICAL BEHAVIOUR. Alessandrini, V. A.; Devega, H.; Schaposnik, F. (International Centre for Theoretical Physics, Trieste (Italy)). Feb 1974. 11p. INIS.

The behavior of an antiferromagnetic system near the critical point is discussed in the context of Wilson's theory of critical phenomena. Using the two-lattice model to describe the antiferromagnetic phase transition, it is shown that the critical behavior is the same as that of a ferromagnetic system. (INIS)

5824 (IS-3545) DETERMINING NONLINEAR PROJECTION SUBSPACES. Georg, D. D.; Keller, R. F. (Ames Lab., Iowa (USA)). Apr 1975. Contract W-7405-eng-82. 105p. Dep. NTIS $5.25.

Recently, the projection method for solving linear systems of equations was extended to nonlinear systems of equations. The nonlinear projection method is an iterative method which allows its user to modify from one to n, the dimension of the system, components at each iteration step. If n components are modified, then it is shown that the iteration is mathematically equivalent to Newton's method. The potential advantage offered by the projection method over the total step methods such as Newton's method is that it may be computationally more effective to modify less than n components at certain iteration steps. If m components of the approximate solution vector are modified using the nonlinear projection method, where l is less than or equal to m less than or equal to n, then the residue vector associated with the new approximation to the solution vector is projected on a subspace of dimension m. Hence, determining a set of m components to be modified at an iteration step is equivalent to choosing an m dimensional projection subspace. One of the goals is to develop criteria for selecting a computationally efficient sequence. In order to meet the above mentioned goal, four separate criteria for determining projection subspaces are developed and analyzed. Then, after certain subsets of nonlinear problems are distinguished and classified by extending the class of almost linear problems, the analysis for subspace selection criteria is extended, and alternative computational algorithms are developed for these subsets. Finally, several example problems are solved using the projection method with the various criteria

as well as Newton's method to illustrate the significant advantages offered by the nonlinear projection method. (auth)

5825 (ITF-74-114P) THEORY OF COMBINATIONAL LIGHT SCATTERING BY SURFACE POLARITONS. Strizhevskii, V. A.; Yashkir, Yu. N. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 33p. (In Russian). Dep. NTIS (US Sales Only) $4.75.

A theory of spontaneous combinational light scattering (CS) by surface polaritons (SP) is developed. The surface electromagnetic fluctuations which are the source of CS on the boundary of two media are calculated. The cases of two media and that of the absorption band between liquid dielectrics are considered. The formulas for the frequency-angular distribution of the CS intensity expressed through the phenomenological parameters of media are obtained and analyzed. It is shown that with application of the scattering angle the line of SP moves along their dispersion curve calculated without taking into account the absorption. The different regularities of the phenomenon which can be observed experimentally are analyzed in detail. (tr-auth)

5826 (ITF-74-119P) MAGNON STATE DENSITIES IN ANTIFERROMAGNETICS WITH THE RUTILE-TYPE STRUCTURE. Sukhorskaya, N. A. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The spectrum of spin waves in antiferromagnetics with the rutile-type structure is investigated taking into account the anisotropy. The singularities in magnon state densities are considered. It is shown that the singularities are connected with the constant energy surfaces whose form changes when external magnetic fields different in their magnitude and direction are applied. The character of singularities is also dependent upon the change of magnetic fields. (tr-auth)

5827 (ITF-74-123P) RESEARCH IN GROUP DECOMPOSITION FOR BINARY DISTRIBUTION FUNCTIONS OF PARTICLE SYSTEMS WITH ELECTROSTATIC INTERACTION. III. The Fourth Virial Coefficient. Yukhnovskii, I. R.; Vysochanskii, V. S.; Golovko, M. F. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 24p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

In the fourth virial coefficient approximation to the behavior of the binary distribution function of mixed ion-dipole systems of three sorts is studied. It is shown that the main value of the first maximum is formed by the second virial coefficient. Each succeeding virial coefficient taken into account leads to the appearance of a new maximum and small correction of the preceding maxima. The largest and smallest possible values of the first maximum are calculated. In the fourth virial coefficient approximation the average force potential is investigated. (tr-auth)

5828 (ITF-74-139P) ANALYSIS OF THE EXCITON ABSORPTION BANDS USING THE METHOD OF MOMENTS. Nitsovich, B. M. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1974. 14p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The possibility of defining the exciton-phonon parameters from the analysis of shape of the light absorption band by molecular crystals is shown by way of example of the exciton-phonon interaction, linear in the phonon creation and annihilation operators. (tr-auth)

5829 (JINR-E4-8789) MICROSCOPIC SOLUTIONS OF THE BOLTZMANN–ENSKOG EQUATION IN THE KINETIC THEORY OF HARD SPHERES. Bogolubov, N. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 13p. Dep. NTIS (US Sales Only) $4.00.

The purpose is to demonstrate that the Boltzmann-Enskog equation, which always was considered as a low density approximation possesses also microscopic solutions, corresponding to the extact movement of particles. (auth)

5830 (KFK-PDV-28) MACHINE TOOL CONTROL, COMPUTER LINKED NUMERICAL CONTROL. Verhaag, E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F. R. Germany)). Oct 1974. 85p. (In German). Dep. NTIS (US Sales Only) $7.25.

An economically attractive control unit was developed for NC machines in production technology. By shifting the functions of conventional NC to the production computer, an NC system of reduced scope is produced: machine tool control. The modular layout described here permits adaptability to very varied tasks, both in the field of production technology and in other branches of industry. The flexibility of the system is shown by its facility for monitoring production, by involving AC systems as well as automatic cutting distribution. The testing and diagnostic aids provided by the system contribute to increased utilization of the whole installation, so that better economy can also be expected. (tr-auth)

5831 (KFK-PDV-29) REQUIREMENTS FOR CONTROL STATION DESIGN. Gutmann, M. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F. R. Germany)). Oct 1974. 24p. (In German). Dep. NTIS (US Sales Only) $4.25.

After an approximate classification of various processes according to levels of automation (low, average, high), the layout of the manual stations on a central desk and on a secondary panel is described as a possibility of designing modern control stations for a plant with a high level of automation. The requirements to be met by control systems in respect to computers are derived from a comparison between two conventional control stations and two computerized control stations. These four control stations are compared from the aspect of disturbance. (tr-auth)

5832 (NOAA-TM-ERL-48) MESOSCALE WIND PREDICTION WITH THE INERTIAL EQUATION OF MOTION. Cornett, J. S.; Randerson, D. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. (USA). Air Resources Lab.). Jan 1975. 29p. (ARLV-351-47). Dep. NTIS $3.75.

A mesoscale wind-prediction model based solely on the inertial equation of motion is verified on an hourly basis against persistence for 33 independent 6-hr periods. The model is also compared with another mesoscale wind-prediction model derived from a horizontal vorticity theorem. The inertial model is demonstrated to be a better model for prediction times ranging from 3 through 6 hr. In the free atmosphere, both models have difficulty outperforming a persistence wind forecast for time periods of 1 to 2 hr and do no better than persistence in the boundary layer. However, the vertical wind-shear forecasts by the inertial model are better than persistence for both the early (1 to 2 hr) prediction times and at lower levels in the atmosphere. (auth)

5833 (SAND-75-0001) DNA/SANDIA SOIL PENETRATION EXPERIMENT AT DRES: RESULTS AND ANALYSIS. Patterson, W. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1975. Contract AT(29-1)-789. 57p. Dep. NTIS $6.00.

The report describes the field test portion of a DNA formulated program for conducting state-of-the-art studies of Earth penetrating weapons and their design. The field penetration tests were in a medium with well defined mechanical properties and they provided a comparison between empirical and theoretical calculations and field test results. The report includes a description of the test site, which was located at The Defense Research Establishment Suffield (DRES), Ralston, Alberta, Canada, projectile, instrumentation, test procedures, test results, data received, and data analysis. The comparison of actual field test data results to pretest predictions is continuing. (auth)

5834 (SAND-75-0041) EBW1: A COMPUTER CODE FOR THE PREDICTION OF THE BEHAVIOR OF ELECTRICAL CIRCUITS CONTAINING EXPLODING WIRE ELEMENTS. Tucker, T. J.; Toth, R. P. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1975. Contract AT(29-1)-789. 82p. Dep. NTIS $7.25.

Resistivity versus specific action data for 23 elemental metals and alloys are combined with a MIMIC language computer program to predict the behavior of electrical circuits containing exploding wire elements. (auth)

5835 (SAND-75-0077) SPACE SHUTTLE SOLID ROCKET BOOSTER (SRB) RECOVERY SYSTEM. Sandia Laboratories Progress Report, March 1974–February 1975. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1975. Contract AT(29-1)-789. 196p. Dep. NTIS $13.00.

A preliminary evaluation of the SRB recovery system baseline as it existed in March 1973 confirmed that the NASA selection of a ribbon drogue and cluster of three ribbon mains provided the best system resulting in reasonable parachute weights. The baseline drogue deployment method (by a tether attached to the ejected nose cap) was objected to, and a computer study was initiated to complement NASA wind tunnel tests. The computer study, wind tunnel test results, and past experience in developing large ribbon parachutes all indicated that the baseline drogue deployment method was not acceptable. An alternate method using a large (15 to 20 ft) pilot chute and heavy line ties was suggested. Predicted inflation loads for the early baseline drogue were significantly higher than those used to design the chute and attachment structure. A higher porosity drogue that provided the required drag and acceptable load levels (226,000 pounds) was recommended. Predicted inflation loads (135,000 pounds) for the main chutes agreed closely with previous NASA predictions. A stress analysis of the parachutes confirmed that the desired design margins existed in both drogue and main chutes. Horizontal ribbons were found to be overdesigned in both chutes, suggesting the possibility of significant weight savings. The need for a drop test program

as an absolute requirement in the parachute development program was stated. (auth)

5836 (SAND-75-8001) AIRCRAFT DROP TEST OF B77 PARACHUTE TEST UNIT (PTU-2) TEST REPORT NO. 7006, SLA NO. R707006. Schultz, R. H. (Sandia Labs., Livermore, Calif. (USA)). Mar 1975. Contract AT(29-1)-789. 185p. Dep. NTIS $12.25.

The second unit (PTU-2) in the B77 parachute test program was dropped on December 12, 1974, from an Air Force F-4 at 0.7 Mach and 6300 feet mean sea level. The purposes of the test were to determine the effectiveness of the lifting parachute system in providing low impact velocity and nearly vertical impact angles and to qualify the two-parachute system for the B77. Both the first-stage lifting parachute and the second-stage recovery parachute were deployed. Conventional reefing was used in the lifting parachute, but the reefing cutter functioned prematurely; thus that concept was not tested on this drop. The unit operated successfully; the similarity of the results of the PTU-1 and PTU-2 tests indicates that the system operation is repeatable and predictable. (auth)

5837 (SAND-75-8224) ROTATIONAL RAMAN SCATTERING SYSTEM FOR MEASURING TEMPERATURE AND CONCENTRATION PROFILES IN TRANSIENT GAS FLOWS. Smith, J. R. (Sandia Labs., Livermore, Calif. (USA)). Mar 1975. Contract AT(29-1)-789. 112p. Dep. NTIS $8.75.

A new method is presented for simultaneously measuring temperature and concentration profiles for diatomic gases in transient flows. A continuous argon laser produces rotational Raman spectra along the laser beam focused in a high-pressure test cell. The spectra are dispersed by a single-pass spectrometer and detected by an image intensifier and a low-light-level television camera. A complete spectral record from the scattering region is obtained from each camera scan every 0.033 second. An analytical expression using a nonrigid-rotator molecule model is developed to determine the temperature and concentration from the Raman spectra. (auth)

5838 (SU-326-P30-33) MATRIX FACTORIZATIONS IN OPTIMIZATION OF NONLINEAR FUNCTIONS SUBJECT TO LINEAR CONSTRAINTS. Goldfarb, D. (Stanford Univ., Calif. (USA). Dept. of Computer Science). Sep 1974. Contract AT(04-3)-326. 45p. Dep. NTIS $5.25.

Several ways of implementing methods for solving nonlinear optimization problems involving linear inequality and equality constraints using numerically stable matrix factorizations are described. The methods considered all follow an active constraint set approach and include quadratic programing, variable metric, and modified Newton methods. (auth)

5839 (UCID-16757) TRANSVERSE ELECTROMAGNETIC FIELD SUPPORTED BY AN INFINITELY CONDUCTING PLANE AND A PARALLEL INFINITELY CONDUCTING STRIP. Logan, J. D.; Yee, K. S.; Chan, W. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1975. Contract W-7405-Eng-48. 18p. Dep. NTIS $4.00.

The problem of determining the distribution of current in two perfect conductors, one an infinite plane and the other an infinitely long strip that is parallel to the plane is studied. It is assumed that the strip carries a current that returns via the plane. Such a system can support a transverse electromagnetic (TEM) wave. Using the TEM mode, the electric and magnetic field in the region around the conductors were numerically calculated and boundary conditions were applied to determine the surface current density on the conductors. By calculating the current density, the degree to which the return current in the plane images the current in the strip can be determined. (auth)

5840 (UCRL-76369) B8 SERIES FOR PRACTICAL METRICATION OF PRESSURE GAUGES. Burton, W. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jan 1975. 13p. (CONF-750115-1). Dep. NTIS $4.00.

From 4th IMOG task group meeting on metrication; G. E. Pinellas Plant, Florida, USA (22 Jan 1975).

The B8 series of preferred numbers makes possible two simple methods of converting pressure gauges from psi graduations to SI graduations. Only the dial need be changed, and even this is not required if the appropriate full-scale dial decal is applied to the existing psi-graduated dial. (auth)

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